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ERRATA

Page 113, line 7 from bottom "Part I" should read "Plate I."

Page 257, line 18 from top "*Corchorus acutangulus* (salúlot)" should read "*Corchorus acutangulus* (saluyot)."

Page 488, line 11 from bottom "membrance" should read "membrane."

Page 694, line 16 from top "FRONDA, F. M., ACELO C. BADELLES AND JUAN S. PADILLA. 1933" should read "FRONDA, F. M., ACELO C. BADELLES AND JUAN S. PADILLA. 1934."

ON RESEARCH [1]

Opinions of Some Successful Scientific, Industrial and Business Executives [2]

You have undoubtedly come prepared to listen to what I may say, but I am sure, even if I made it my life work to develop thoughts similar to those I shall presently read to you, I would fall far short in the results. In bringing these opinions before you, I have attempted to classify them and give them a certain continuity.

Recognition of need for research

We are now passing through a period which clearly brings to mind the fact that civilization unarmed by science is at a terrible disadvantage in a struggle for existence; and we must realize that this arming cannot be done at short notice.—ANDREW MELLON.

The intellectual stimulus accompanying great upheavals, however they originate, finds expression in unusual achievements in science. —GEORGE ELLERY HALE.

Indeed, it is practically impossible to pitch upon any problem in modern life whose complete solution does not involve an appeal to several lines of scientific approach....

In other words, the price of a sound, progressive national life is in these times widespread and intelligent scientific research....

In a general way it had long been a subject of comment that the Germans had succeeded in exploiting scientific research for the improvement of their industry and agriculture to a degree unrivalled by other countries. But with the outbreak of the war the crushing efficiency of the many new technical devices of the German army lent added emphasis of the most dramatic character to the appreciation of what had in that country been accomplished in these lines....

• Certainly the national character of the obligation to foster research, both in pure and applied science, as widely as our resources will permit, cannot be called in question by any thoughtful observer

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[1] General contribution from the College of Agriculture No. 346.

[2] Extracts from an address delivered by Dr. B. M. Gonzalez, Dean, College of Agriculture, before the Second Philippine Science Convention, Manila, February 16, 1933.

of the present trend in the development of civilization, and it is essential in this connection that we conceive of research as the organized technique of science itself for its own propagation.—JAMES ROWLAND ANGELL.

There seems to be no department of human activity in which the rule of thumb man has not come to realize that science which he formerly despised is useful beyond the scope of his own individual experience....

We are not limited, however, to a military objective, for when the war is over the international competitions of peace will be resumed. No treaties or leagues can prevent that, and it is not desirable that they should, for no nation can afford to be without the stimulus of competition.

In that race the same power of science which has so amazingly increased the productive capacity of mankind during the past century will be applied again and the prizes of industrial and commercial leadership will fall to the nation which organizes its scientific forces most effectively.—ELIHU ROOT.

The function of the executive in a research institution

Care must be taken to secure competent executives, either from the ranks of those whose primary training has been along research lines and who have shown capacity for handling men and complicated problems or from those of executive capacity and experience who have shown a proper sympathy for the requirements of research....

It is essential that whoever is responsible for the direction and success of the industrial research undertaking should be a man with a broad outlook, a full appreciation of all of the factors of the business problem, and a man who can sympathize with and appreciate the varying points of view which he encounters and who can harmonize all of the activities into a smoothly-working machine.— FRANK B. JEWETT.

The management must not only be able to adapt its methods to the psychology of the workers, but it must also be able to change its plan of research as the work develops and as discoveries are made.—C. E. K. MEES.

The prosecution of research today is upon an entirely different basis. Not only do those in the same science coördinate their work, if they are to attain the highest results, but all branches of science

are regarded not as separate and unrelated agencies, but as parts of a common effort. A research started in a purely physical field may find its solution in a chemical reaction or a physiological process. The research men of a nation are not isolated individuals but an organized and coöperating army.— HENRY S. PRITCHETT.

A spirit of coöperation should be encouraged among all types of research laboratories, as no greater good to society can arise than from a wider distribution of the duties and responsibilities of research. Accordingly, well established research laboratories should be willing to coöperate and render informative service necessary for the establishment and organization of other research laboratories.— ANDREW MELLON.

On the organization of research work

The real work of organization and research must be done by men who make it the whole business of their lives.— ELIHU ROOT.

And we thus come to the ideal organization of research, which may be stated in a few words: "getting good research men and letting them do what they want to." In practice this limit of disorganization cannot be achieved in an institution of any size. . . .

Results in research cannot be obtained by hard work alone; moreover, elaborate planning, which is such an important factor in modern production, can easily be a disadvantage in research. The situation is perhaps analogous to that of war. To go to war without a plan is quite fatal. To go to war with a rigid plan which can not be changed as fresh circumstances arise may also be fatal.—C. E. K. MEES.

A research laboratory searches for knowledge, particularly in its own field. Two things are important in this connection: one is an insatiable thirst for knowledge; the other is an ample library and record facilities where this knowledge can be sought, orderly assembled, and stored away.— C. W. THOMPSON.

• More specifically, this obligation to foster research means, first, the providing for a greatly enlarged personnel with much better fundamental training than is at present available. It means, second, the securing of the necessary facilities of laboratories, apparatus and all the physical conveniences that are involved in scientific work. It means, third, the procuring of sufficient freedom from other duties to permit research workers to give their full and undivided attention throughout such periods as may be necessary to the completion of their research undertakings.— JAMES ROWLAND ANGELL.

Whatever the scheme finally adopted to provide for an expansion in the domain of fundamental research and the development of competent industrial research workers, care must be taken to insure that pressure from the industries will never be so great as to withdraw those men who can render the greatest service by continuing as investigators in the field of pure research and the training of younger men. Such a course would be suicidal if long continued and I mention the point because of the fact that my experience indicates a considerable tendency on the part of industries which have benefited from industrial research to endeavor to attract into their service the best of the university research men. I confess that the temptation to do this is very great and that the monetary inducements which industry can offer to the individual are large and not easily to be withstood by a man whose normal human reaction is for the material welfare of his family.— FRANK B. JEWETT.

Finance and research

Research is essentially a speculation, but it differs from most speculations in that the odds seem to be weighted heavily in favor of the speculator, so that if industrial research is undertaken with competent men and is allowed to carry on in the face of difficulty and failure, profit is almost inevitable.— C. E. K. MEES.

The expenditures for research in a large laboratory comprise the salaries and expenses of executives; office, library, shop, storeroom, and building operation and maintenance; salaries of research men and assistants; supplies and house charges, which will include as well special charges for shop and office work; and traveling expenses incurred during investigational inquiries and during the attendance of members of the research staff at appropriate scientific gatherings.— WILLIAM A. HAMOR AND GEORGE D. BEAL.

It is on the men in independent research and in our educational institutions that the great burden of scientific advancement must always rest, and from them that the inspiration of the younger generation of oncoming scientific workers is derived. What we need above all things is the better support of these men. They should not, by the necessities of living and the cost of equipment, be forced into our industrial laboratories....

We may make these academic posts so attractive to the student of science that he will seek and occupy them permanently because of the opportunities they afford him to advance knowledge by original re-

search without anxiety for bread and family and equipment. It is true that money can not buy genius, but many a genius in science has defaulted because he has had to eat.— HERBERT HOOVER.

The training of researchers

Successful research demands trained investigators, and these cannot be produced in a day. It also demands adequate provision of funds, not merely during the feverish moments of war, but throughout those long periods of calm, when the foundations that underlie the success or failure of a nation are laid.—GEORGE ELLERY HALE.

No form of human effort is more highly individualistic, or more exacting in its demands upon the vitality of the worker, than research....

Above all they should have creative instinct, which is the driving force underlying research. —H. L. TRUMBULL.

No extensive and successful industrial research growth can be looked for unless provision is made for a continuing supply of competent men of broad general training and a specific and thorough training in the methods of scientific research. —FRANK B. JEWETT.

Research workers should be men of critical judgment and unquestioned integrity. It is not sufficient that they refrain from deceiving others; they should ever be alert to avoid deceiving themselves.— WEBSTER N. JONES.

A high level of preliminary scientific education, a far-reaching general professional training and a moderate degree of specialization, such should, according to the views of the writer, be the qualifications which the agricultural scientist of tomorrow should be expected to supply.— E. MARCHAL.

The human factor in research

A research laboratory is an organization made up of human beings with all the advantages and limitations which that involves. In my opinion, the more really human are the members of a research organization, the more successful it will be. Or, to put it another way, the less it operates along the lines of discipline, such as we think of in connection with the army, the more successful it will be. The enthusiasm of a worker must never be dampened, although properly it may be directed. He should always be encouraged when he shows a thirst for knowledge. All that may be necessary is tactfully to guide his thirst for knowledge to the particular problems on which he should be working....

In a research laboratory, while there must be a certain willingness to be driven and to report promptly knowledge already acquired, there must also be an unwillingness to be driven unduly on problems requiring study and careful investigation.—C. W. THOMPSON.

There is no lack of money, no lack of material facilities, no lack of courage, no lack of approval on the part of directors, for we have long ago learned that material facilities are easy to obtain, that money spent in properly directed fundamental research, large though the sums may be, is small in comparison with the direct and indirect returns, and finally that apparent courage in deciding to go ahead is not so very courageous after all when it is exercised by men of ability, training and experience who have shown themselves competent in their own fields, whether these fields be within the laboratories or within the precincts of the executive offices.

What then is it that should stop us from an immediate attack if we are so sure of the ultimate result? The answer is the simple, three-letter word 'men'. Not mere human male bipeds but men endowed by nature with at least a modicum of the spirit of scientific research to which has been added, either through fortune, personal initiative, parental solicitude or a far-sighted policy on the part of the State, that orderly training and opportunity for expansion of intellect without which natural talents are of little avail.—FRANK B. JEWETT.

Research workers are of many different types, and an elastic outlook on the part of the management is a dominant factor in the production of the best results. However efficiently a laboratory may be organized and however energetically the staff may endeavor to produce results, if they do not have the inspiration to make the discoveries which should follow applied research effort, the laboratory will be sterile.—C. E. K. MEES.

Only young men of marked promise should be encouraged to do advanced work. David Starr Jordan expressed the opinion that it is 'no use loading a $10,000 education on a 50-cent boy'....

Is his measure of success largely financial or does he appreciate that the attainment of happiness, health, and opportunity for service to humanity are as important as a large income?—WEBSTER N. JONES.

Research in universities and educational institutions

Except for the special laboratories of a few large industrial organizations and the smaller laboratories of individuals, both scientific and industrial research have been carried on in the laboratories

of educational institutions by individuals who are at once teachers and investigators. The combination of teaching and research should doubtless be continued, for it is profitable alike to student and teacher and tends to promote both research and scientific training. It is possible on the one hand for students to render valuable research assistance while studying in a college or university, and on the other hand it is almost inevitably true that contacts of the teacher with advanced students increase his value as an investigator. But already pure research has become so broad in its applications, and so insistently demanded by practical interests, that it constitutes an over heavy burden on educational institutions and must therefore be taken care of in a measure by the provision of special organizations.— THEODORE N. VAIL.

The university with its great thinkers and vast and precious teaching resources is undoubtedly the most favorable milieu for the purely scientific training of the agricultural scientists of the future.— E. MARCHAL.

In general, University research is carried on in the interstices of other duties, and the only wonder is that so much of it is produced, and that on the whole it is of so respectable a character....

It is a matter of common knowledge that the most serious limitation of the research productivity of these institutions is occasioned by the overwhelming burden of classroom instruction which many of the men are obliged to carry. Such classroom work is not only destructive to research because of the sheer intellectual and physical fatigue which it occasions, but also, and perhaps more significantly, because of the interruption to attention and the close observation of critical phenomena which it compels.—JAMES ROWLAND ANGELL.

Teaching without research soon becomes hide-bound, uninteresting, of little inspirational or cultural value.— R. W. THATCHER.

Research in pure science

Everywhere and always, pure science constitutes the active source from which, although often it may be by long and devious paths, true practical progress is surely derived.— E. MARCHAL.

For a number of years the world has been gradually developing a better appreciation of the scientific method and of scientific research largely because the benefits derived through its application to industry have been strikingly demonstrated. There are many examples of the commercial value of researches begun in pure science with no idea of immediate industrial application.— H. E. HOWE.

While the solution of specific industrial problems and the attainment of specific industrial objects will be of immense value, the whole system will dry up and fail unless research in pure science be included within its scope.—ELIHU ROOT.

Research in the biological and physical sciences takes two forms; industrial research (which is the application of science), and research in pure science. Obviously, there must first be a pure science before there can be an application. I am aware that there is a twilight zone between them, but no scientist has difficulty in finding the borders.—HERBERT HOOVER.

Research in industry

In an address some years ago, Whitney of the General Electric Company referred to research as the parent of industrial growth....

I know of no more significant tribute to research than to compare a list of industrial common stocks measured by the frequency with which they occur in the portfolios of our investment trusts and a list of companies measured by their activity in industrial research. The order of names on each list is almost identical.—BRODERICK HASKELL JR.

Success in genuine industrial research presupposes all the qualities which are applicable to success in pure science, and, in addition, other qualities, executive and personal, more or less unessential in the pure research laboratory.—ANDREW MELLON.

The close connection in recent years between industrial progress and what may be called industrial research is significant. The large industrial enterprises have been developed as much through the organization of their scientific departments as through that of their operating departments. These departments of industrial research will undoubtedly be continued along present lines for, while their maintenance is costly in the aggregate, the expenditure is negligible by comparison with practical results when spread over a large production.—THEODORE N. VAIL.

Research in agriculture

The knowledge of the results accomplished in agriculture by national and state scientific investigation and coöperation is perhaps too wide-spread to make it necessary even to mention that subject.—AMBROSE SWASEY.

The Higher Agricultural Institute situated in the country and in rural surroundings, where at every point the instruction can be refreshed and invigorated by practical demonstration, with its experiment farm, its research stations staffed with eminent scientists should prove a focus of applied science in direct and constant touch with the great general intellectual center provided by the university town from which, consequently, it should not be too far distant....

In certain special schools, though classed as of the "Higher" rank, there is a tendency to make the professional instruction degenerate into a kind of technical initiation into the practice of such and such a branch of agricultural industry or speculation. Under the guise of exercises in the adaptation of theory to practice, the student is required to carry out processes and manual operations, which could be far better learned after the completion of his studies during the course of the stage which every student should pass through before starting on his professional career....

Another danger to be avoided in the higher agricultural course is in the writer's opinion the tendency towards an exaggerated specialization....

The march of agricultural progress might be made far more rapid and sure, and much of the labor, expense and trouble of testing and trials might be avoided if our agricultural scientists were given a superior equipment of pure science and could go direct to the original sources of the great discoveries for the maintenance of their activities....

The most urgent need of today is rather for true scientists, competent to achieve success in original research, than it is for able technicians or merely popular lecturers. The responsibility for training such men lies with higher agricultural education, but if the work is to be adequately accomplished, higher agricultural education must develop and improve its methods and organization.—E. MARCHAL.

It is a sad mistake so to emphasize the practical or economic importance of agricultural research work that our constituency gets the idea that only men of practical farm experience should be used in agricultural investigational work....

We must point out that the skilled scientists (not necessarily trained farmers) must be used in the investigations; and that agricultural operations like industrial operations are founded on true scientific principles, and that only those who are trained to recognize and under-

stand these principles can accurately interpret the observations which are made in the field or laboratory and draw the correct conclusions therefrom....

The work of the agricultural experiment stations is somewhat better known and enjoys a somewhat more desirable position in the public mind than does general university research; but even here it is evident that station men feel that they do not have all the public support to which the importance and value of their work should entitle them.—R. W. THATCHER.

Publicity in research

It is felt that a satisfactory staff composed of able research men, a proper selection of fundamental problems, and a judicious handling of patents will result in a natural publicity. This publicity should be so effective that no salesmanship on the part of the university will be necessary. The industries, like the public, are interested in results and accomplishments, not in propaganda or advertising.—D. B. KEYES.

Science has been popularized to an extent that has made it a faith with many people that have no adequate means of appraising it. A public trust is placed therefore in the hands of those who are able to interpret properly the economic significance of research.—BRODERICK HASKELL JR.

Pitfalls in research

Research is not merely the collection of existing facts and data on a given subject; that is but an incidental though important phase of the work. One type of research creates new knowledge and gives new power over materials; the other type seeks to supply this newly created knowledge to the solution of specific problems. The two are really interdependent, equally complex and necessary.—H. E. HOWE.

Your isolated and concentrated scientist must know what has gone before, or he will waste his life in doing what has already been done, or in repeating past failures. He must know something about what his contemporaries are trying to do, or he will waste his life in duplicating effort.—ELIHU ROOT.

Many tendencies of the time indicate both the opportunity and the necessity for further effort. Not least of these is a widespread public preference for sensational discovery, even if based on little or no evidence, rather than for solid accomplishment of more sober sort. Pseudo-scientific journals, taken by thousands of enthusiastic amateurs, often feed their readers on the veriest nonsense in the guise

of science. Charalatans offering fabulous wares are successful in securing appropriations from Congress. Such indications suffice to show the importance of rendering the sound results of scientific and industrial research more widely known, in language easily understood by all intelligent readers.—GEORGE ELLERY HALE.

The common opinion seemed to be that all that was necessary was to construct a building or buildings, put in some machinery and instruments, gather together a few human beings, label the whole, a research laboratory and proceed to 'research'. . . .

Every day I meet men or groups of men who have acquired a certain superficial knowledge of research matters and a limited vocabulary of its terms and who talk convincingly of the future of industrial research and of the enormous material benefits to be derived from the extension of this form of activity. They fail utterly to realize that the mere dubbing of a man by some research title does not make him any more a real research investigator than sewing a pair of wings on a tunic makes a man a military aviator. They also fail to realize that even under the most favorable conditions as to human material, the mere getting together of a group of men does not bring a research laboratory into being.— FRANK B. JEWETT.

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THE DIGESTIBILITY BY THE CARABAO OF FLINT CORN SILAGE [1]

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The importance to the animal husbandman of knowing the digestibility of feeds is apparent. As Henry and Morrison (1923) point out "the digestible matter is obviously the only portion of the feed which is of use, since the remainder passes out in the feces without even having entered the body." So far as the present authors know, the digestibility of flint corn silage by carabaos has not been determined. As information on the subject should be of practical value the study reported in this paper was undertaken.

The objects of this study were to determine: (*a*) how much of the nutrients contained in flint corn silage are digested by native carabaos, and (*b*) their coefficients of digestibility.

This study was carried on in the College of Agriculture, University of the Philippines, from April 30 to May 10, 1931, covering a period of 11 days. According to Jordan and Hall (1900) "the collection period should not be less than five days, and probably need not be over a week."

MATERIALS

Corn silage

The corn silage used was produced in the College and was preserved in the silo for five months. It was of the Yellow Flint variety and when cut for the silo was just beyond the roasting stage; the lower leaves were turning yellow. The corn was then two months and 20 days old.

Animals

Four healthy Philippine carabaos, one steer and three cows were used. Jordan and Hall (1900) state that "very often only two animals are used in a single test, but four or more give more reliable

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results, since the influence of individual peculiarities is less when an average is taken." The animals ranged in age from four years to eight years and four months, the average being 5 years, 10 months. They weighed from 417 to 511 kgm., averaging 472 kgm.

Barn and tools

The barn has a concrete floor which made the collection of feces free from foreign matter possible.

Empty kerosene cans and shovels for the collection of feces and wide-mouthed bottles for samples for analysis were used. A small galvanized iron spoon was used in getting samples of feces for analysis. A "Fairbanks" balance, sensitive to 0.2 kgm. was used for weighing the feed consumed and feces voided.

Feeding and management

Before the experiment was started, the animals were subjected to a preliminary test period of 10 days during which they were fed only corn silage. This test was necessary in order to clear the alimentary canal of the previous feeds. During this preliminary period the feces were examined daily to detect the first appearance of corn silage. Kernels of corn first appeared in the feces of two animals on the fourth day and in those of the other two on the sixth and seventh days. It was deemed safe to conclude that on the day the actual experiment was begun the animals were digesting only corn silage. Jordan and Hall (1900) suggest that the preliminary feeding period for ruminants should be from eight to ten days.

During the day, or from 6:00 a. m. to 6:00 p. m. the animals were placed in separate stanchions. From 6:00 p. m. to 6:00 a. m. they were turned in an open space, also with concrete flooring, where they were free to move around.

During the experimental period, the animals were individually fed at about 7:00 and 11:00 a. m. and 4:00 p. m. Common salt and water were also regularly given. At each feeding time the animals were allowed all the silage they would consume, the procedure being to give the feed in portions so there would be little left over. None of the animals lost weight, showing that they received sufficient nutrients from the feed. Ewing and Wells (1914) consider that animals given all the corn silage they will consume twice daily are on maintenance ration. The daily feed consumption of each animal was recorded.

Throughout the whole experimental period, one person was always on watch day and night, ready to collect the feces. The ani-

mals were kept on a concrete floor except at weighing time. When the animal was taken to the scales for weighing, a second person followed behind with an empty can ready to catch the feces.

Every time an animal defecated, the feces were collected, weighed and samples taken for analysis. The collecting was done by scraping the feces from the concrete floor, except in a few instances when an empty can was held at the hind part of the animal in the act of defecation. To facilitate collection, clean empty kerosene cans and shovels were always in readiness near the animals. The amount of feces passed out by each animal daily was thus obtained.

The chemical analysis

A sample of the corn silage for chemical analysis was obtained daily. Two-liter, wide-mouthed bottles with cork stoppers were used for this purpose. At every feeding time representative portions were taken from the pile of silage to be fed to the animals and placed in the bottle. At the end of the day the accumulated sample was submitted for analysis. A few drops of formaline were added to prevent deterioration. One sample was analyzed for all the animals each day.

As containers for samples of the feces, one small, wide-mouthed bottle, properly labeled, was provided for each animal each day. Every time an animal defecated representative portions, taken from the different parts, were placed, after the feces were weighed, in a bottle. With the preservative, the accumulated sample of the feces of each animal for the day was submitted for analysis.

In the analytical laboratory, the feed and feces were ground in a meat grinder and portions were taken for moisture, ash, crude protein, crude fiber, nitrogen-free-extract, and fat determinations.

The methods of chemical analysis used were in accordance with the directions embodied in the *Official and Tentative Methods of Analysis of the Association of Official Agricultural Chemists* (1925).

DISCUSSION OF RESULTS

Silage consumption, feces voided and the analyses

Table 1 shows that the animals consumed corn silage in amounts ranging from 21.0 to 26.6 kgm. a day, averaging 24.6. kgm. This amount represented the consumption of 5.2 kgm. for every 100 kgm. live weight. The amount of feces voided ranged from 15.1 to 21.2 kgm., averaging 17.8 kgm. a head daily, or 3.8 kgm. feces for 100

kgm. live weight. In a previous study on carabaos, Villegas and Taleon (1932) reported 5.1 kgm. corn silage consumed, and 3.5 kgm. feces voided for every 100 kgm. live weight.

The average analyses of corn silage and feces follow:

	Corn silage	*Feces*
Dry matter	30.72 per cent	14.14 per cent
Crude protein	2.25 " "	1.49 " "
Crude fiber	8.16 " "	3.28 " "
Nitrogen-free-extract	18.04 " "	7.21 " "
Fat	0.37 " "	0.22 " "

The corn silage of the College contained more dry matter, crude protein, crude fiber, and nitrogen-free-extract than that reported by Henry and Morrison (1923) and Bailey (1908). In fat, however, these authors give higher figures, Henry and Morrison, 0.6 and Bailey, 0.8 per cent.

Nutrient consumption and coefficient of digestibility

The coefficient of digestibility of each nutrient, or the percentage digested, was obtained by first computing the amount consumed by the animal in one day and the amount undigested or passed out in the feces. The difference between the two represented the amount digested, which is only approximately correct according to Henry and Morrison (1923). Dividing the amount digested by that consumed and multiplying the quotient by 100 gives the coefficient of digestibility.

The amount of one nutrient fed to an animal was obtained by multiplying the amount of the nutrient contained in one kgm. feed by the amount of feed consumed. For example, on the first day of the experiment, animal No. 30 consumed 23.3 kgm. of corn silage, which by analysis contained 27.87 per cent dry matter or 0.2787 kgm. dry matter a kilogram. The animal then consumed 6.49 kgm. of dry matter that day.

The quantity of one nutrient undigested or that portion passed out in the feces was found by multiplying the amount of the nutrient contained in one kgm. feces by the weight of feces voided. Thus, on the first day of the experiment, No. 30 voided 12.0 kgm. of feces, which by analysis contained 14.93 per cent dry matter. The animal, therefore, passed out 1.79 kgm. dry matter. On the first day of the experiment the animal digested 4.7 kgm. dry matter, which represented 72.42 per cent of the amount fed.

In like manner, the coefficient of digestibility of the dry matter, crude protein, crude fiber, nitrogen-free-extract and fat by the individual animal was obtained daily.

Table 2 shows that, on an average, a carabao consumed 7.50 kgm. dry matter, 0.55 kgm. crude protein, 2.01 kgm. crude fiber, 4.42 kgm. nitrogen-free-extract and 0.09 kgm. fat a day. Out of these, however, 5.00 kgm. or 66.27 per cent dry matter, 0.29 kgm. or 51.81 per cent crude protein, 1.43 kgm. or 69.92 per cent crude fiber, 3.17 kgm. or 70.89 per cent nitrogen-free-extract, and 0.05 kgm. or 49.18 per cent fat, were digested.

Table 2 shows the coefficient of digestibility of corn as reported by Henry and Morrison (1923) and Bailey (1908), the former using immature dent corn, the latter flint, at glazing stage. While carabaos were used in the present study, it is presumed that the two authorities cited above used oxen. Comparing the present study with that by Bailey (1908), which is also for flint corn, it is seen that our percentages are lower, notably in fat.

Nutrients consumed per 1000 kgm. live weight

Table 3 shows the amount of the different nutrients digested by the carabao for every 1000 kgm. live weight, computed by dividing the amount of a nutrient digested by the weight of the animal in kgm. multiplied by 1000. For example, No. 30 weighing 511 kgm. digested 5.57 kgm. dry matter. Therefore the animal digested 10.90 kgm. dry matter for every 1000 kgm. live weight. It is shown that the four animals required from 9.74 to 11.03 kgm. dry matter per 1000 kgm. live weight; 0.55 to 0.68 kgm. crude protein; 2.92 to 3.17 kgm. crude fiber; 6.35 to 6.91 kgm. nitrogen-free-extract; 0.10 to 0.13 kgm. fat; 10.09 to 10.93 kgm. total digestible nutrients. The nutritive ratio was 1:15.07 to 1:17.35. The sum of the digestible crude protein, crude fiber, nitrogen-free-extract, and fat multiplied by 2.25 gave the total digestible nutrients. On an average, the four carabaos digested 10.59 kgm. dry matter, 0.63 kgm. digestible crude protein, and 10.63 kgm. total digestible nutrients for every 1000 kgm. live weight; the nutritive ratio was 1:15.87, or one part protein to 15.87 carbohydrate equivalents.

Compared with the maintenance requirements of an ox at rest in the stall, (Henry and Morrison, 1923) the carabaos in this experiment consumed less dry matter than the ox, but the other nutrients were about the same.

Digestible nutrients

The digestible nutrients the feed contained were computed by multiplying the chemical analysis by the coefficient of digestibility; this product is the amount of the different nutrients in a feed that is utilized by the animals. For example, by using the analysis of the feed and table 2, it may be seen that the corn silage used contained 20.36 kgm. digestible dry matter in every 100 kgm. (0.3072 × 0.6627 × 100). By this process of computation, the corn silage was found to contain the following digestible nutrients in every 100 kgm.:

Dry matter	20.36 kgm.
Crude protein	1.17 "
Carbohydrates	18.50 "
Fat	0.18 "
Total nutrients	20.08 "
Nutritive ratio	1:16.16

Henry and Morrison (1923) give the following figures for corn silage, immature:

Dry matter	21.0 kgm.
Crude protein	1.0 "
Carbohydrates	11.4 "
Fat	0.4 "
Total nutrients	13.3 "
Nutritive ratio	1:12.3

Comparing the two tables it is seen that the corn silage studied in this College had about the same digestible dry matter and crude protein and carbohydrates; the total nutrients were much higher; the fat was lower; and the nutritive ratio was wider.

SUMMARY

This study on the digestibility by the carabaos of flint corn silage yielded the following data:

1. Yellow Flint corn silage of the College had the following chemical composition:

Dry matter	30.72 per cent
Crude protein	2.25 " "
Crude fiber	8.16 " "
Nitrogen-free-extract	18.04 " "
Fat	0.37 " "

2. The coefficient of digestibility of the corn silage was found to be:

Dry matter	66.27 per cent
Crude protein	51.81 " "
Crude fiber	69.92 " "
Nitrogen-free-extract	70.89 " "
Fat	49.18 " "

3. Native carabaos at rest used the following per 1000 kgm. live weight:

Digestible dry matter	10.59 kgm.
Digestible crude protein	0.63 "
Total digestible nutrients	10.63 "
Nutritive ratio	1:15.87

4. The corn silage contained the following digestible nutrients in every 100 kgm. of feed:

Dry matter	20.36 kgm.
Crude protein	1.17 "
Carbohydrates	18.50 "
Fat	0.18 "
Total nutrients	20.08 "
Nutritive ratio	1:16.16

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TABLE 1

Showing the amount of feed consumed and feces voided

DATE	HERD NO. 30		HERD NO. 39		HERD NO. 45		HERD NO. 54	
	Feed consumed	Feces voided	Feed consumed	Feces voided	Feed consumed	Feces voided	Feed consumed	Feces voided
1931	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*
April 30	23.3	12.0	25.5	20.6	25.6	13.0	22.3	11.8
May 1	26.0	11.0	29.2	19.0	29.4	21.2	22.6	7.2
May 2	26.6	14.4	27.8	18.8	24.8	16.2	24.6	12.8
May 3	20.1	18.8	21.9	20.8	21.2	15.0	17.4	14.6
May 4	21.6	17.0	22.4	14.2	20.4	16.4	18.0	13.4
May 5	26.8	13.4	27.8	20.4	23.2	10.6	18.8	10.6
May 6	25.2	21.8	27.6	24.4	24.4	25.4	19.6	25.4
May 7	23.4	18.2	spoiled		24.9	17.4	19.4	17.6
May 8	29.0	14.4	18.3	22.6	28.3	16.5	24.5	16.6
May 9	33.4	26.0	29.4	26.0	28.2	24.4	22.8	13.4
May 10	27.6	22.6	26.4	25.2	27.0	21.2	21.4	22.6
Average	25.7	17.2	26.6	21.2	25.2	17.9	21.0	15.1

TABLE 2

Showing the amount of nutrients consumed, digested, and their coefficients of digestibility

ANIMAL	DRY MATTER			CRUDE PROTEIN			CARBOHYDRATES						FAT		
							Crude fiber			Nitrogen-free-extract					
	Consumption	Amount digested	Coefficient of digestibility	Consumption	Amount digested	Coefficient of digestibility	Consumption	Amount digested	Coefficient of digestibility	Consumption	Amount digested	Coefficient of digestibility	Consumption	Amount digested	Coefficient of digestibility
Herd No.	*kgm.*	*kgm*	*per cent*	*kgm.*	*kgm.*	*per cent*	*kgm*	*kgm.*	*per cent*	*kgm.*	*kgm.*	*per cent*	*kgm.*	*kgm.*	*per cent*
30	7.88	5.57	70.23	.58	.35	58.87	2.12	1.59	73.62	4.61	3.53	74.32	.09	.05	43.09
39	8.15	5.22	63.74	.61	.32	52.28	2.17	1.45	65.47	4.78	3.29	68.43	.10	.06	51.74
45	7.72	5.15	66.77	.56	.28	48.70	2.06	1.48	70.74	4.52	3.20	70.88	.09	.06	50.78
54	6.25	4.06	64.35	.47	.23	47.41	1.71	1.22	69.86	3.77	2.65	69.95	.08	.04	51.12
Average	7.50	5.60	66.27	.55	.29	51.81	2.01	1.43	69.92	4.42	3.17	70.89	.09	.05	49.18
Dent corn silage, immature. Henry & Morrison (1923)			64			53			68			66			71
Flint corn silage, glazing, by ruminants, Bailey (1908)			75			65			77			79			82

TABLE 3

Showing the amount of nutrients digested per 1000 kilograms live weight

ANIMAL	DRY MATTER	CRUDE PROTEIN	CARBOHYDRATES		FAT	TOTAL DIGESTIBLE NUTRIENTS	NUTRITIVE RATIO
			Crude fiber	Nitrogen-free-extract			
Herd No.	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*1:*
30	10.90	.68	3.11	6.91	.10	10.93	15.07
39	10.61	.65	2.95	6.69	.12	10.56	15.25
45	11.03	.60	3.17	6.85	.13	10.91	17.18
54	9.74	.55	2.92	6.35	.12	10.09	17.35
Average	10.59	.63	3.03	6.72	.11	10.63	15.87

SELECTION OF VARIETIES AND STRAINS OF MUNGO (PHASEOLUS AUREUS ROXB.) [1]

PURIFICACION M. CAGUICLA

WITH TWO TEXT FIGURES

The mungo plant (*Phaseolus aureus* Roxb.) is one of the most popular legumes in the Philippines. It is grown extensively in many provinces of the Islands, notably Pangasinan, Nueva Ecija, Cavite and Batangas. In these provinces it is raised on a commercial scale. In many other provinces it is grown mainly for home consumption. Because of its high protein content, mungo is highly recommended for food. The mungo plant, being a nitrogen fixing crop, is also used for green manuring. In some parts of Pangasinan and Nueva Ecija and in the plantations of some large sugar centrals it is planted in rotation with rice or sugar cane. Occasionally the seeds are used as feed for live stock, especially for chickens.

Because of the value of mungo as a food and as a soil-enriching crop, a study of varietal types and selection of desirable strains within a variety with respect to yield in green materials and seeds under Los Baños conditions is important. Hence, this work was undertaken.

REVIEW OF LITERATURE

While mungo has been mentioned extensively in literature as one of the soil-enriching legumes, no critical study of the kind here attempted has been reported. A few of the published works which have some bearing on the present investigation will be cited briefly.

According to Dulhi and Fuller, as cited by Kingman (1915), the mungo is grown in India as an intercrop with millet or cotton. When grown alone it is sown broadcast at the rate of 10 to 13 kilograms per hectare. These authors state that sowing is done after a rain, and maturity comes at different times of the year depending upon the variety and the soil and climatic conditions.

Watt (1908) claims to have found that very good results could be obtained by green manuring with mungo when it is turned under at

[1] Thesis presented for graduation, 1932, with the degree of Bachelor of Agriculture from the College of Agriculture, No. 345; Experiment Station contribution No. 885. Prepared in the Department of Agronomy under the direction of Dr. N. B. Mendiola, and Mr. T. Mercado.

the age of six to eight weeks. He states that this age is the best for green manuring because it is the blooming stage of the plant, when it has its highest amount of green material.

Saleeby (1911) recommended mungo as one of many leguminous plants which can be cultivated to great advantage in abaca plantations. For, besides its value as food, it enriches the soil with nitrogen, which is essential to the growth of abaca.

Kingman (1915) recommended yellow seeded mungo, black seeded mungo, and green seeded mungo as good for cover crops. They cover the ground well, choke out the weeds and in addition give a good yield of seeds.

According to San Miguel (1916), the important points which govern selection work in mungo are productivity, evenness of maturity, heavy production of vegetable matter, resistance to disease and suitability to season conditions.

OBJECTS OF THE PRESENT WORK

This work was undertaken with the following objects: (*a*) to assemble as many varieties of mungo as possible; (*b*) to study the variability in yield of seeds and of green materials per plant; (*c*) to détermine the yield of different varieties and to select the promising ones; and (*d*) to select the highest yielding strains in a variety.

TIME AND PLACE OF THE WORK

The work was conducted in the Plant Breeding Field in the Experiment Station and in the Plant Breeding Laboratory of the College of Agriculture, University of the Philippines from March, 1931 to March, 1932, covering a period of approximately twelve months.

The data reported in these studies were obtained from two season plantings. The first, or wet season planting was on May 11, 1931, and the second, or dry season planting on October 3, 1931.

MATERIALS AND METHODS

Varieties used

The local varieties of mungo used in this work were secured [2] from twelve different regions in the island of Luzon, Philippines, covering seven provinces. These varieties from different places fall

[2] The writer wrote to the presidents of 20 municipalities requesting that she be supplied with sample of seeds of mungo to be used for experimental purposes. Eleven presidents responded, sending samples, for which acknowledgement is here made.

under three main groups which are easily distinguished by seed color; namely, yellow, green, and black mungo. The place of origin and date on which seeds were received for this study are shown in table O.

TABLE O

Varieties of mungo used in this work

VARIETY NAME[a]	SOURCE	DATE RECEIVED
1. College Green	College of Agriculture	April 1, 1931
2. Binañgonan Green	Binañgonan, Rizal	April 15, 1931
3. Urdaneta Green	Urdaneta, Pangasinan	April 29, 1931
4. College Yellow	College of Agriculture	April 1, 1931
5. Lipa Yellow	Lipa, Batangas	April 9, 1931
6. Candelaria Yellow	Candelaria, Zambales	April 10, 1931
7. Calamba Yellow	Calamba, Laguna	April 11, 1931
8. Tanauan Yellow	Tanauan, Batangas	April 12, 1931
9. Lemery Yellow	Lemery, Batangas	April 19, 1932
10. Muñoz Yellow	Muñoz, Nueva Ecija	April 20, 1931
11. Sariaya Yellow	Sariaya, Tayabas	April 22, 1931
12. Rosales Yellow	Rosales, Pangasinan	April 29, 1931
13. Aliaga Black	Aliaga, Nueva Ecija	June 1, 1931

[a] These names were coined by the writer for convenience in this study. These mungoes bear no variety names in their places of origin.

Sorting of different strains

When received, the sample representing each variety was examined at once and the seeds sorted according to color.

There is a considerable range of variation among yellows and some variation among greens. Not much variation, however, was observed among the dark colored seeds or black seeds. In the writer's judgment the color types seem to affect the nature of the seed coat and the general shade of each group. It was possible, therefore, to establish other color types from the three distinct groups. For example, the yellow mungo can be further differentiated into dull yellow, shiny yellow, and brownish yellow. Likewise the greens can be easily separated into dull green and shiny green. In any sample of a mungo variety these differently colored seeds were found in various proportions. The percentages of these colored strains were determined in each lot of seeds of a given variety. The seeds of one color are designated as belonging to a strain.

Preparation of the land and planting the seeds

The land was prepared thoroughly by plowing and harrowing several times before the seeds were planted. The different seed

strains found in each variety were planted separately. Each strain was planted in a row. The rows were 60 centimeters apart and the seeds were drilled in the row at a distance of 30 centimeters between hills. Five or six seeds were planted to a hill. Practically the same care was given to all strains planted.

Field observations

Duration of germination was observed and the percentage of germination of each strain in a variety was taken. One month after planting, the variability of some agronomical characters, such as hairiness of leaves per plant was studied. The leaves were described as narrow medium or broad. As there seems to be an association between the color of base and the color of node of the plants, the correlation of these morphological characteristics was studied.

Observations on the average height and weight of plants belonging to each strain were made during the three periods of vegetative growth. These were: (*a*) before flowering, (*b*) full bloom and (*c*) after flowering.

Insects attacked the plants. The larvae were picked off by hand. Later on, on the suggestion of Dr. L. B. Uichanco of the Entomology Department the plants were dusted with calcium arsenate powder. The plants were sprayed once every 15 to 20 days.

No treatment was given to diseased plants. The dried leaves that fell to the ground were collected and burned.

Chemical analyses of the plants

The plants, pulled up while they were in flower, were dried and prepared into samples for analysis for nitrogen, phosphorus (P_2O_5), and ash. These analyses were performed in the Experiment Station, of the Chemistry Department.

The remainder of the plants in the field were allowed to mature. As soon as the pods turned black, a sign of maturity, the plants were pulled up, and after the roots were washed were taken to the laboratory.

Laboratory observations

In the laboratory the plants from each strain were weighed individually. The average weight of plants of each strain was then computed. After weighing, the pods from each plant were removed and placed in separate paper bags. The pods from different strains were dried the same length of time in the sun. When thoroughly dry they were weighed separately and the average dry weight of pods from each plant was determined. The seeds were then removed from the

pods and weighed separately. The average dry weight of seeds of each plant was recorded. The color of seeds produced by each plant from each strain was critically noted and compared with that of the original color of the strain planted.

RESULTS AND DISCUSSION

Different strains found

It may be seen in table 1 that the different varieties received from different sources were not uniformly of one color but contained mixtures of seeds of different colors. Of the 13 varieties, Calamba Yellow, Lemery Yellow and Sariaya Yellow varieties had five color strains each. Dull Yellow, shiny yellow, dull green, shiny green and brownish yellow strains were observed in Calamba Yellow and Sariaya Yellow varieties. The Lemery Yellow variety had dull yellow, shiny yellow, dull green, brownish yellow and black strains.

In the College Yellow, Tanauan Yellow, Lipa Yellow and Candelaria Yellow varieties, four strains; namely, dull yellow, shiny yellow, dull green and shiny green were represented.

Binañgonan Green variety had three color strains of seeds. These were dull green, shiny green and greenish yellow. The College Green variety had four color types, two of which were green and two, dull yellow and purplish brown. The Muñoz Yellow variety was composed of three kinds of yellow, dull yellow, shiny yellow and brownish yellow. Two classes of yellow were found in Rosales Yellow variety. The Urdaneta Green and the Aliaga Black varieties were found to be free from mixture, the former being pure green and the latter pure-black. If the color predominating in the seed samples studied could be taken as representing the typical color of the sample then College Yellow, Tanauan Yellow, Lipa Yellow, Candelaria Yellow and Lemery Yellow are typically dull yellow; and Calamba Yellow, Muñoz Yellow, Sariaya Yellow and Rosales Yellow are shiny yellow. Likewise, the College Green and the Urdaneta Green varieties are both dull green; the Binañgonan Green variety is shiny green. The Aliaga Black variety is pure black. The existence of several strains within a given local variety suggests at once the possibility of extracting more desirable strains.

Observations on the seeds of strains that changed from their original color to greenish red in storage showed that out of the total number of seeds of the shiny green strains from Binañgonan Green variety, 14.75 per cent changed to greenish red in storage; 9.64 per cent of the dull green strain from Urdaneta Green variety and 11.40

per cent of the dull green from the College Green variety also changed to greenish red. The results of the observations indicate that the seed color of green varieties of mungo undergoes some changes during storage. Similar observations were made with other varieties but no such change was noted.

Germination at wet and dry season plantings

The different strains of mungo seeds of the wet and dry season plantings exhibited almost the same duration of germination. With the exception of the College variety, the germination in both seasons lasted for three days. The College varieties germinated in four days. There was, however, a slight variability in the percentage of germination, observed not only among the varieties but also among the strains within a variety.

In all strains the seeds planted in the dry season gave a lower percentage of germination than those planted in the wet season. In the wet season, there was recorded a general average of 81.40 per cent of germination, in the dry season only 73.29 per cent. By planting seeds in the dry season which were intended for the wet season planting, an average of about 8 per cent of the seeds lost their vitality. When ranked as to germination ability, the native local varieties in wet season planting stand as follows:

Best germination, 90 per cent or more; Tanauan Yellow and Lipa Yellow.

Good germination, 80 to 90 per cent: Lemery Yellow, Muñoz Yellow, Urdaneta Green, Rosales Yellow, Sariaya Yellow, Binañgonan Green, College Yellow and Calamba Yellow.

Fair germination, 70 to 80 per cent: College Green.

Hairiness and form of leaves of different strains of mungo

Different plants under each strain of mungo showed differences in the degree of hairiness and form of leaves. Some of the plants in the same strain had hairy leaves, others had smooth leaves and still others were intermediate between hairy and smooth. In some cases plants in one strain had only smooth or hairy leaves. In some plants the leaves were intermediate between smooth and hairy. It would seem that hairiness and form of leaves are varietal characteristics. To illustrate this, the different strains from the College Yellow variety may be cited. Of the 359 plants of dull yellow strain, 25 individuals had smooth leaves; 219 plants, intermediate; and 115 plants, hairy. Out of 390 plants of shiny yellow strain, 43 individuals had

smooth leaves and 347 plants were intermediate. No plant of this strain was hairy. All the 22 plants of shiny green strain were intermediate between hairy and smooth.

As to form of leaves, the strain of the College Green variety may again be used as an example. One hundred eighty-five plants from 359 individuals of dull yellow strain had narrow leaves, 47 plants had medium sized leaves and 127 plants had broad leaves. Out of 390 plants of shiny yellow strain, 256 plants had narrow leaves; 127 plants, medium sized leaves; and 27 plants, broad leaves. Out of 322 plants of dull green strain 89 plants had narrow leaves; only 3, medium sized leaves; and 130 plants, broad leaves. Out of 22 plants of shiny green strain only one plant had narrow leaves and 21 plants had broad leaves.

The above data indicate that the different strains of mungo studied are variable as to forms and degrees of hairiness of leaves. Since some strains had either smooth or hairy leaves, it is probable that by judicious selection, types with this constant morphological characteristic can finally be established.

The form of leaves varied considerably even among the plants in each strain. This apparent lack of uniformity may suggest that the different varietal types were heterozygous for this character. Since the form of leaves involves complexity of size inheritance, the interpretation of the apparent segregation of mungo strains with respect to this trait does not fall within the scope of this study. It is sufficient to state that the appearance of diversity of types regarding hairiness and form of leaves may be due to hybrid nature of local varieties of mungo.

Color of base of stem and node of the plant

One of the most striking characteristics found among the young mungo seedlings was the association of the color of base of stem and color of node. In all varieties, the mungo plants with green base generally had purple nodes, while those with purple base invariably had either purple or green nodes. The majority of the plants from each strain with green base had purple nodes. The Tanauan Yellow variety is an example.

Out of 342 plants of the dull yellow strain from Tanauan Yellow variety 301 had green base of stem and 240 had purple nodes, and 41 had purple base of stem and 102 had green nodes. From 376 plants of shiny yellow strain from Tanauan Yellow variety only 5 plants had purple stem bases and 240 had purple nodes; 371 plants had green bases of stem and 136 had green nodes.

The coefficient of correlation between the color of base and color of node is $r = 0.9754 \pm 0.0012$. These figures leave no doubt as to the significance of high correlation that exists between these two agronomic characters, suggesting that perhaps these characters are linked; or if caused by the same genetic factor, it would mean that this factor affects the base of stem in one way and the nodes in an entirely different way.

Duration of flowering and maturity of seeds

It was found that the duration of flowering and maturity of seeds varied according to season of planting. The wet season culture generally had longer duration of flowering and maturity of seeds than the dry season planting. Moreover, in the wet season culture, the local varieties showed variation in the age and duration of flowering and maturity of seeds. The different strains found in each variety, however, had in nearly all cases the same duration of flowering and maturity of pods. Binañgonan Green variety flowered the earliest, the Aliaga Black variety, the latest. The Binañgonan Green variety flowered at the age of only 38 days after planting, while the Aliaga Black variety flowered at the age of 56 days. Nearly all the different strains of the other varieties began flowering at the age of 48 to 49 days. It is interesting to note that the shiny green strain of Tanauan Yellow variety began flowering 36 days after planting. This indicates that an early strain might be isolated from a late variety. The shiny green strain of the College Green variety flowered at the age of 49 days; the dull green and dull yellow strains of the same variety flowered at the age of 57 days.

The Binañgonan Green variety exhibited the shortest duration of flowering; the College Green variety, second; the College Yellow, Urdaneta Green and Rosales Yellow, third; Calamba Yellow, Tanauan Yellow, Lipa Yellow, Candelaria Yellow, Lemery Yellow, Muñoz Yellow and Sariaya Yellow, fourth; and Aliaga Black, fifth. Binañgonan Green had a duration of flowering of 13 days; College Green, 15 days; College Yellow, Urdaneta Green, and Rosales Yellow, 16 days; Calamba Yellow, Muñoz Yellow, and Sariaya Yellow, 17 days; and Aliaga Black, 19 days. The shiny green strains of Tanauan Yellow variety had only 16 days duration of flowering.

The maturity of pods of the different varieties ranged from 5 to 10 days. All of the pods of Binañgonan Green matured within five days; Muñoz Yellow, Sariaya Yellow, Urdaneta Green and Rosales Yellow, within 6 days; Candelaria Yellow and Lemery Yellow, 7 days; Calamba Yellow, Tanauan Yellow, (except in one strain) and

Lipa Yellow, 8 days; College Yellow and College Green, 9 days; and Aliaga Black, 10 days.

With the wet season planting, therefore, the Binañgonan Green matured first; Candelaria Yellow and Lemery Yellow, second; Calamba Yellow and Tanauan Yellow, third; College Yellow and College Green, fourth; and Aliaga Black, fifth.

Mungo seeds planted during the dry season generally flowered and matured earlier than those planted during the wet season. Most of the strains of the dry season culture flowered at the age of only 40 to 46 days after planting, which was about 3 to 6 days earlier than those planted during the wet season. In the varieties, Tanauan Yellow, Candelaria Yellow, Binañgonan Green, Lemery Yellow, Urdaneta Green and Rosales Yellow, the duration of maturity of pods was the same in both the wet and dry season plantings. On the other hand, plants of Aliaga Black variety grown in the dry season matured 3 days earlier than those planted in the wet season. In the dry and wet season cultures, Binañgonan Green variety flowered and matured the earliest of all the varieties planted; the Aliaga Black variety flowered and matured the latest. It is of interest that Binañgonan Green was the only one which proved to be a dwarf variety.

Average weight of green materials and height of plant

The amount of green materials and height of plant of mungo varied among the different strains in a variety. Such variability was also noticed among the 13 local varieties of mungo planted. Among the different strains in a variety, it may be seen in table 2 that plants grown during the wet season had more green materials than those grown during the dry season (see fig. 1 and 2). In wet and dry season plantings, the greatest amount of green materials per plant was attained during the flowering period. The three strains of College Yellow variety may be cited as an example. These three strains varied in weight per plant from 24.51 to 27.32 grams before flowering and 77.05 to 79.10 grams at the time of flowering. But these weights gradually decreased to a range of from 70.72 to 73.93 grams after flowering. The same was true with the other strains in each local variety. The decrease in weight of vegetable matter after flowering was due to the falling of dry and old leaves after flowering, the insect pests *Phytometra chalcites* Esp., *Thermesia rubricans* Bussd., *Mocis ondata* Fabr., *Protoporce convolvuli* Linn., and to the attacks of leaf spot caused by *Cercospora cruenta* Sacc.[3]

[3] The insects were identified by Mr. Arsenio Y. Coronel of the Entomology Department and the fungus was identified by Miss Victoria B. Mendiola of the Plant Pathology Department.

Ten strains were very seriously attacked by this disease and the pests. The plants were unable to continue flowering and died before reaching maturity. From a total of 43 strains planted, 8 strains yielded a total weight for the entire plant at the time of flowering of more than 95 grams. These were the shiny yellow and dull green strains from Tanauan Yellow variety; dull yellow and dull green strains from Lipa Yellow, shiny yellow from Lemery Yellow; dull green from Urdaneta Green, and dull yellow and shiny yellow from Rosales Yellow. None of the strains showed an increase in the amount of green materials after flowering.

These data indicate that the mungo plants for green manuring should be plowed under while they are in flower, for at this stage they have the greatest amount of vegetable matter.

Since only 10 strains were found highly susceptible to disease

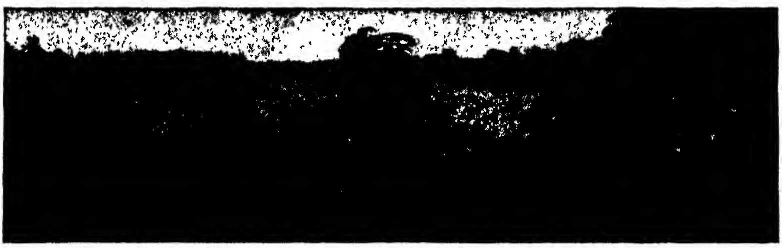

Fig. 1.—Wet season culture of mungo showing the vigorous vegetative growth of the plants. Note the height of the dwarf variety, Binañgonan Green, in the middle.

and pests, it seems to indicate that the other strains may be considered resistant or tolerant to the presence of the disease and pests. If such is the case it may be possible to isolate some resistant strain or strains within a given local variety.

During the dry season planting the amount of green materials was also found to be greatest while the plants were in flower. The growth of the plants was rather slow after the flowering period was over. This condition seems reasonable for at this period the plants had attained maturity.

As may be seen in table 3 the average weight of green materials and height of plants varied considerably. In the wet season planting, Urdaneta Green variety had the largest amount of green materials; Lipa Yellow, second; and Rosales Yellow, third. The Urdaneta Green variety had an average of 165.2 grams of green materials per

plant; Lipa Yellow, 98.97 grams; and Rosales Yellow, 96.62 grams. The other varieties had average weights of green materials lower than 95 grams. The tallest variety grown was Urdaneta Green with an average height of 125.00 centimeters. The shortest variety was Binañgonan Green with an average height of only 44.50 centimeters. The range in height of the different mungo varieties clearly indicates that tall and dwarf types may be recognized in this legume.

In the dry season planting, Aliaga Black variety had the largest amount of green matter, an average of 12.39 grams per plant. Binañgonan Green variety had the lowest, 4.47 grams per plant. From these data it may be concluded that a decidedly larger amount of green matter was obtained from mungo planted during the wet season than when planted during the dry season, therefore, mungo plants intended for green manuring should be grown during the wet season and plowed under while they are in full flower.

Fig. 2.—Dry season planting showing the heights of the plants of the different varieties. (Photographs by Photographic Division, Soils Department.)

Chemical analyses of the plants

Triplicate samples of each strain were analyzed by the Department of Chemistry. The results of the analyses are shown in table 4. The average amount of ash varied from 12.58 to 15.91 per cent, nitrogen from 1.91 to 3.19 per cent and phosphorus (P_2O_5) from 0.68 to 1.26 per cent. Binañgonan Green had an average composition of 15.91 per cent ash and 3.19 per cent nitrogen content, the latter being the largest amount found in any of the varieties of mungo analyzed. College Yellow showed the lowest ash content, having an average of 12.58 per cent for the three strains and Urdaneta Green gave the lowest, 0.69 per cent nitrogen content. The other strains within each variety varied only slightly as to the amount of ash, nitrogen and phosphorus content.

The variations in chemical composition show that in case the land lacks nitrogen, Binañgonan Green is the best to plant for this

variety exceeds the others in this food element. If, however, the soil is deficient in phosphorus, Lipa Yellow may be recommended for green manuring.

Yield of the different strains and varieties of mungo per plant

While the amount of green materials of mungo plants was greater in the wet season than the dry season planting the yield of seed per plant in the dry season, was decidedly greater than in the wet season (see table 5). The production of seeds in the wet season was very much lower than in the dry season. This statement holds true for nearly all the strains planted. Calamba Yellow variety produced nearly the same amount of seeds per plant from the wet as from the dry season cultures. The mungo plants grown in the dry season produced more than twice as much seed as those grown in the wet season. The green and black strains planted in both seasons produced more seed than the other strains. The highest yielding strain was the dull green from Lemery Yellow variety with an average yield of 1.6 grams per plant; shiny green from Binañgonan Green was second with 1.525 grams; dull green from Candelaria Yellow was third with 1.382 grams; and Aliaga Black fourth, with 1.172 grams.

By reference to table 5 it may be seen that the dull green from Lemery Yellow, was the most productive in seeds; the Aliaga Black, however, which occupied a fourth place in production can be classed with the dull green strain from Lemery Yellow variety on account of uniformity of its yield in the two seasons of planting under Los Baños conditions.

Purity test

In order to determine the purity of the original strains, seeds from different varieties were planted and the color characters of the seeds produced were recorded.

There were observed strains of mungo that produced seeds not entirely true to their original color. These are the shiny green, dull green and greenish yellow from Binañgonan Green variety; dull yellow from Candelaria Yellow; dull green from Lipa Yellow; shiny yellow from Muñoz Yellow; shiny yellow from Sariaya Yellow; and dull yellow from Rosales Yellow. The shiny green from Binañgonan Green variety had 2 plants with dull green color of seeds; and 3 plants greenish yellow out of 29 plants that produced seeds. The dull green strain had one plant out of 4 plants that produced shiny green seeds and the greenish yellow strain out of 14 plants had

one plant with dull green seeds and 6 plants with shiny green seeds. Out of 40 plants of dull green strains from Lemery Yellow, 1 plant produced shiny yellow seeds and 2 plants produced black seeds. The shiny yellow from College Yellow variety had one plant with dull yellow seeds out of 21 plants that produced seeds. Dull green strain from Calamba Yellow variety had one plant with dull yellow out of 10 plants. Shiny yellow from Muñoz Yellow variety had one plant with brownish yellow seeds out of 10 plants. The shiny yellow from Sariaya Yellow variety had two plants with brownish yellow seeds out of 21 plants. Out of 12 plants the dull yellow strain from Rosales Yellow variety had one plant that produced shiny yellow seeds. The remainder of the plants in each strain produced seeds true to their original color.

The appearance of off types with respect to seed color in mungo varieties indicates that some of the strains were heterozygous for this character. The mungo plant is a highly self-fertilizing plant, although there is also an appreciable degree of cross-pollination. To interpret color segregation on factor differences was not attempted in this study. It is of interest, however, that in these results it was found that black gave nothing but black, yellow, mostly yellow with some green; and green mostly green with a few yellow.

SUMMARY OF CONCLUSIONS

The results obtained from this study may be briefly summarized as follows:

1. The different local varieties of mungo (*Phaseolus aureus* Roxb.) used in this study when classified on the basis of color of seed fall under the three main groups; namely, Yellow, Green and Black.

2. The thirteen varieties studied were mixtures of differently colored seeds or strains. Most of these strains were found heterozygous, at least with respect to color of seeds, of base, of stem and node of stems, hairiness and form of leaves.

3. The color of seeds of some mungo strains changed to a certain extent while in storage.

4. No significant differences were found on the duration of germination of seeds planted in the wet or dry season although the percentages of germination of mungo seeds were greater in the wet season planting than in the dry season.

5. The germination in the wet season stands as follows:

Best germination—Tanauan Yellow and Lipa Yellow.

Good germination—Lemery Yellow, Muñoz Yellow, Urdaneta Green, Rosales Yellow, Sariaya Yellow, Binañgonan Green, College Yellow and Calamba Yellow.

Fair germination—College Green.

6. The duration of flowering and maturity of mungo was longer in the wet season than in the dry. The wet season culture was seriously affected by diseases and pests.

7. The Aliaga Black and Binañgonan Green varieties were found to be resistant to the leaf spot diseases and to the pests. The Rosales Yellow and Urdaneta Green were found to be very susceptible to pests, being the first varieties attacked by the insect pests. The shiny green strains were from College Yellow, College Green, Calamba Yellow, Lipa Yellow, Tanauan Yellow, Candelaria Yellow and dull green from Sariaya Yellow varieties; the dull yellow from Muñoz Yellow, shiny yellow from Lipa Yellow and brownish yellow from Lemery Yellow were found to be very susceptible to diseases and pests.

8. Of the local varieties studied, the Binañgonan Green was found to be a dwarf variety. The tall variety found was Urdaneta Green.

9. The yield in green materials of mungo was higher in the wet season than in the dry season culture. On the other hand, the production of seeds was higher in the dry than in the wet season. This indicates that under Los Baños conditions mungo should be planted during the wet season if it is to be utilized for green manuring purposes, and during the dry season if the object is to obtain high production of seeds.

10. The yield in green materials of mungo was found to be greatest when the plants were in flower, hence they should be plowed under when they are at this stage.

11. The Binañgonan Green variety was found to have the highest content of nitrogen. The shiny green strain from this variety gave exceptionally high nitrogen content and was finally isolated for this characteristic. Therefore, it may be recommended for planting in land deficient in nitrogen. The Lipa Yellow variety, because of its high phosphoric acid content, can be recommended for planting in land deficient in phosphorus. The strain selected from this variety was dull green.

12. Of the different varieties tried, Urdaneta Green, Lipa Yellow and Rosales Yellow proved to be heavy yielders of green materials. The strains with exceptionally high production of green materials are: shiny yellow, and dull green strains from Tanauan Yellow variety;

dull yellow and dull green strains from Lipa Yellow; shiny yellow strain from Lemery Yellow; dull green strain from Urdaneta Green and dull yellow and shiny yellow strains from Rosales Yellow.

13. The Aliaga Black variety, shiny green and dull green strains from Binañgonan Green were found more suitable to Los Baños conditions for seed production than the other varieties studied.

14. This study on different mungo varieties shows that by further selection varietal types or strains of uniform seed color, high yield in green materials and seed pods, high content of nitrogen and phosphorus, early and late maturity periods and types with some degree of disease resistance may be isolated. It is believed that a further study with a more detailed account of genetic and morphological characteristics would be of material help in the establishment of distinct types and the standardization of Philippine mungo (*Phaseolus aureus* Roxb.) varieties.

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TABLE 1

Showing the percentage of mixture of differently colored seeds of mungo, Phaseolus aureus Roxb.

VARIETY NAME	NUMBER OF SEEDS STUDIED	NUMBER OF COLOR STRAINS FOUND	PERCENTAGE OF DIFFERENT COLORED SEEDS							
			Dull yellow	Shiny yellow	Dull green	Shiny green	Brownish yellow	Purplish brown	Black	Greenish yellow
College Yellow	9,109	4	54.818	31.179	13.416	0.587				
College Green	7,431	4	1.889		94.200	0.123		3.788		
Calamba Yellow	11,584	5	38.120	55.248	5.542	0.055	1.035			
Tanauan Yellow	11,524	4	52.217	43.027	4.568	9.188				
Lipa Yellow	12,220	4	78.036	0.752	21.063	0.149				
Candelaria Yellow	9,372	4	47.659	43.559	8.557	0.225				
Binañgonan Green	5,725	3			7.074	89.266				3.660
Lemery Yellow	12,481	5	60.991	1.682	31.890		0.770		4.667	
Muñoz Yellow	8,721	3	0.393	97.420			2.187			
Sariaya Yellow	3,317	5	6.749	88.801	0.241	0.120	4.089			
Urdaneta Green	10,000	1			100.00					
Rosales Yellow	7,748	2	14.790	85.210						
Aliaga Black [a]		1								

[a] No actual counts were made of the seeds of Aliaga Black variety but they appeared to be uniformly black.

TABLE 2

Showing the average weight of green materials and height per plant at three different stages of different strains

VARIETY NAME	STRAINS FOUND IN EACH VARIETY	WET SEASON PLANTING						DRY SEASON PLANTING					
		Before flowering		On flowering		After flowering		Before flowering		On flowering		After flowering	
		Weight of plant	Height of plant	Weight of plant	Height of plant	Weight of plant	Height of plant	Weight of plant	Height of plant	Weight of plant	Height of plant	Weight of plant	Height of plant
		grams	*cm.*	*grams*	*cm.*	*grams*	*cm.*	*grams*	*cm.*	*grams*	*cm.*	*grams*	*cm.*
College Yellow	Dull yellow	24.56	56.50	77.05	95.00	70.72	98.00	2.81	16.00	4.56	30.00	3.86	36.00
	Shiny yellow	24.51	56.50	79.10	98.00	73.93	97.00	2.50	16.00	4.51	30.00	3.66	36.00
	Dull green	27.32	58.00	77.20	95.00	73.40	99.00	3.63	16.50	7.32	30.00	6.50	38.00
	Shiny green[a]	19.00	37.00										
College Green	Dull yellow	27.34	60.00	76.90	95.00	73.07	102.00	2.31	16.00	4.58	30.00	3.68	36.00
	Dull green	30.26	63.00	79.47	97.00	71.41	102.00	3.92	16.90	7.50	31.00	6.80	39.00
	Shiny green[a]	15.66	37.80										
Calamba Yellow	Dull yellow	26.30	58.50	78.15	96.95	73.19	99.00	2.91	18.00	6.30	35.00	5.70	38.50
	Shiny yellow	27.61	58.50	78.03	99.95	74.12	113.00	3.50	17.00	7.61	34.00	7.10	37.50
	Dull green	28.42	59.10	85.90	94.80	78.92	110.00	4.11	17.00	8.42	32.00	7.72	39.10
	Shiny green[a]	12.00	29.00										
	Brownish yellow	28.41	59.80	84.15	93.70	80.82	110.00						
Tanauan Yellow	Dull yellow	36.62	60.00	84.15	93.70	80.82	110.00	3.00	18.00	6.60	31.50	5.90	40.10
	Shiny yellow	36.35	58.80	96.91	103.00	89.54	115.00	3.05	18.00	6.35	29.50	5.50	38.80
	Dull green	38.56	58.50	95.8	109.00	89.73	115.00	4.35	17.90	8.56	29.00	8.01	38.00
	Shiny green[a]	14.30	30.80										
Lipa Yellow	Dull yellow	38.35	60.50	99.45	105.70	89.80	110.00	4.03	17.00	8.35	30.00	7.93	40.00
	Dull green	38.05	59.90	98.50	105.50	88.50	110.00	4.09	17.00	9.30	29.50	8.80	39.00
	Shiny green[a]	12.90	32.00										
Candelaria Yellow	Dull yellow	26.80	58.52	83.80	92.80	78.15	101.00	3.16	17.00	6.51	28.00	5.80	35.00
	Shiny yellow	28.10	50.00	80.10	96.30	77.90	98.00	3.00	18.00	8.00	31.00	5.31	40.00
	Dull green	27.90	50.50	81.40	97.80	79.83	101.00	3.93	18.00	5.13	28.50	7.53	38.50
	Shiny green[a]	14.00	40.10										
Binañgonan Green	Dull green	21.40	38.00	40.46	40.00	48.30	45.00	1.80	10.50	3.50	19.50	2.90	28.00
	Shiny green	19.50	38.00	38.91	40.00	42.90	44.50	1.51	11.50	3.40	20.00	2.80	28.50
	Greenish yellow	20.50	38.00	38.40	40.50	42.50	44.00	1.61	10.50	3.51	19.00	2.70	29.00
Lemery Yellow	Dull yellow	27.00	50.50	94.50	102.50	82.95	110.00	2.95	19.00	7.00	30.00	6.10	39.00
	Shiny yellow	29.00	59.90	98.80	104.50	88.91	110.00	3.36	20.00	7.00	32.00	6.30	40.00
	Dull green	27.15	50.60	93.20	106.00	80.68	110.00	4.09	18.00	9.15	30.00	8.55	39.00
	Black	29.00	59.50	91.60	105.00	81.49	110.00	4.03	18.00	9.50	31.00	8.70	42.00
	Brownish yellow[a]	12.60	31.00										
Muñoz Yellow	Dull yellow[a]	15.80	31.60										
	Shiny yellow	29.22	52.50	88.80	108.00	79.52	113.00	4.26	17.00	9.22	30.00	8.57	42.00
	Brownish yellow	29.50	55.30	80.30	98.00	78.40	109.00	4.09	17.00	9.52	33.00	9.05	44.00
Sariaya Yellow	Dull yellow	30.30	66.50	80.45	98.00	76.80	105.00						
	Shiny yellow	31.15	66.90	85.45	98.50	80.10	101.00	3.85	18.00	9.50	35.00	8.04	44.50
	Dull green	15.80	35.50[a]										
	Shiny green	61.10	35.80[a]										
	Brownish yellow	32.50	68.80	82.80	95.70	79.53	104.00						
Urdaneta Green	Dull green	46.30	78.50	105.20	115.00	91.82	123.00	5.06	25.00	10.80	35.00	8.29	45.00
Rosales Yellow	Dull yellow	48.40	76.80	97.14	112.00	91.10	123.00	4.00	24.00	9.20	39.00	8.22	42.00
	Shiny yellow	48.60	75.80	96.10	110.00	99.10	120.00	4.88	25.00	9.41	36.00	8.03	41.00
Aliaga Black	Black	20.93	51.00	57.65	76.00	49.90	79.00	5.38	23.00	11.39	36.00	10.03	46.00

[a] The plants were attacked by leaf spot caused by *Cercospora cruenta* Sacc. and died at flowering stage.

TABLE 3

Showing the average weight of green materials and height per plant of three different stages of different varieties

VARIETY NAME	WET SEASON PLANTING						DRY SEASON PLANTING					
	Before flowering		On flowering		After flowering		Before flowering		On flowering		After flowering	
	Average weight of plant	Average height of plant	Average weight of plant	Average height of plant	Average weight of plant	Average height of plant	Average weight of plant	Average height of plant	Average weight of plant	Average height of plant	Average weight of plant	Average height of plant
	grams	*cm.*	*grams*	*cm.*	*grams*	*cm.*	*grams*	*cm.*	*grams*	*cm.*	*grams*	*cm.*
College Yellow	23.84	51.80	77.78	96.00	70.77	98.00	2.98	16.16	6.452	33.21	4.67	36.60
College Green	24.66	53.60	78.14	96.00	72.29	102.00	3.11	16.45	7.04	33.71	5.24	37.50
Calamba Yellow	24.56	52.98	81.54	96.24	76.76	108.10	3.52	17.30	8.44	36.51	6.84	38.30
Tanauan Yellow	31.47	52.02	90.08	99.70	84.89	112.00	3.45	17.96	8.17	33.21	6.47	48.96
Lipa Lellow	29.76	50.80	98.97	105.60	89.10	110.00	4.06	17.00	9.82	32.96	8.36	39.50
Candelaria Yellow	24.20	47.28	81.70	95.60	78.62	100.00	3.33	17.60	7.54	32.31	5.88	37.80
Binañgonan Yellow	20.47	38.00	39.25	40.16	35.56	44.50	1.66	10.80	4.47	22.71	2.80	28.50
Lemery Yellow	25.05	50.30	94.52	106.00	83.50	110.00	3.10	18.70	9.16	33.91	7.44	40.00
Muñoz Yellow	24.64	46.40	84.50	103.00	78.96	111.00	4.17	17.00	10.37	33.71	8.81	43.00
Sariaya Yellow	25.17	54.70	82.90	97.40	78.61	103.00	3.85	18.00	9.50	38.21	8.64	44.50
Urdaneta Green	46.30	78.50	105.20	115.00	99.92	125.00	5.06	23.00	11.80	38.21	9.09	45.00
Rosales Yellow	44.50	75.90	96.62	111.00	91.05	121.50	3.95	24.00	9.47	39.00	7.97	41.00
Aliaga Black	20.93	51.00	57.65	76.00	49.90	97.00	5.38	23.00	12.39	39.42	10.03	46.00

TABLE 4

Analyses of green materials at blooming stage of the wet season planting[a]

VARIETY NAME	STRAINS ANALYSED IN A VARIETY	ASH	NITROGEN	PHOSPHORUS (P_2O_5)
		per cent	*per cent*	*per cent*
College yellow	Dull yellow	12.75	2.52	0.67
	Shiny yellow	12.69	2.73	0.88
	Dull green	12.32	1.98	0.50
	Average	12.58	2.61	0.68
College Green	Dull yellow	11.16	2.60	0.79
	Dull green	14.36	2.21	0.69
	Average	12.76	2.40	0.74
Calamba Yellow	Dull yellow	15.20	2.43	0.40
	Shiny yellow	14.16	2.31	0.81
	Dull green	14.29	2.64	0.93
	Brownish yellow	13.44	2.54	0.98
	Average	14.27	2.48	0.78
Tanauan Yellow	Dull yellow	14.31	2.51	1.25
	Shiny yellow	13.87	2.76	1.12
	Dull green	13.57	2.64	0.84
	Average	13.91	2.65	1.07
Lipa Yellow	Dull yellow	14.04	2.22	0.90
	Dull green	13.60	2.35	1.69
	Average	13.82	2.28	1.26
Candelaria	Dull yellow	13.75	3.10	0.50
	Shiny yellow	14.97	2.33	0.94
	Dull yellow	14.14	2.49	0.78
	Average	14.28	2.66	0.74
Binañgonan Green	Shiny green	15.71	3.37	1.06
	Dull green	15.94	3.04	0.76
	Greenish yellow	16.08	3.17	1.26
	Average	15.91	3.19	1.02
Lemery Yellow	Dull yellow	13.61	2.05	1.13
	Shiny yellow	13.78	2.08	0.83
	Dull green	16.08	2.22	0.94
	Black	17.16	2.54	1.08
	Average	15.14	2.25	1.00
Muñoz Yellow	Shiny yellow	11.92	2.33	0.69
	Brownish yellow	12.44	2.30	0.79
	Average	12.18	2.32	0.72
Sariaya Yellow	Dull yellow	14.75	2.55	1.03
	Shiny yellow	14.00	2.60	0.92
	Brownish yellow	12.04	2.27	0.61
	Average	13.60	2.47	0.85
Urdaneta Green	Dull green	12.57	0.69	0.98
Rosales Yellow	Dull yellow	14.70	2.71	1.03
	Shiny yellow	14.56	2.71	1.04
	Average	14.63	2.71	1.04
Aliaga Black	Black	14.82	1.91	1.06

[a] Analyzed by Experiment Station, Department of Agricultural Chemistry.

TABLE 5

Showing the comparative yield of each strain of mungo

VARIETY NAME	STRAINS	WET SEASON PLANTING: Average weight of entire plant after harvest	WET SEASON PLANTING: Average dry weight of pods and seeds per plant	WET SEASON PLANTING: Average weight of seeds per plant	DRY SEASON PLANTING: Average weight of entire plant after harvest	DRY SEASON PLANTING: Average dry weight of pods and seeds per plant	DRY SEASON PLANTING: Average weight of seeds per plant
		grams	*grams*	*grams*	*grams*	*grams*	*grams*
College Yellow	Dull yellow	47.08	.708	.216	3.607	.843	.562
	Shiny yellow	49.18	.360	.213	3.036	.881	.645
	Dull green	51.56	.740	.403	4.866	1.057	.795
	Average	49.273	.603	.277	3.936	.927	.667
College Green	Dull yellow[a]				3.550	.970	.680
	Dull green	58.47	.500	.470	4.650	1.350	.850
Calamba Yellow	Dull yellow	42.45	.845	.790	3.788	1.146	.788
	Shiny yellow	40.93	.360	.250	2.770	.850	.550
	Dull green	57.29	.850	.590	5.886	1.726	1.152
	Brownish yellow	45.00	.400	.100			
	Average	47.187	.614	.433	4.148	1.240	.880
Tanauan Yellow	Dull yellow	51.87	.885	.609	3.688	1.602	.856
	Shiny yellow	48.12	.411	.220	2.676	.756	.468
	Dull green	59.38	.595	.120	5.841	1.655	1.241
	Average	53.123	.630	.316	4.068	1.337	.855
Lipa Yellow	Dull yellow	51.32	.553	.216	4.534	1.534	.929
	Dull green	61.512	.887	.320	6.566	2.167	1.227
	Average	56.416	.720	.268	5.550	1.850	1.078
Candelaria Yellow	Dull yellow	40.88	.820	.280	4.511	1.233	.817
	Shiny yellow	42.11	.460	.212	2.067	.717	.433
	Dull green	54.63	.825	.371	6.534	2.027	1.382
	Average	45.873	.702	.288	4.370	1.322	.877
Binañgonan Green	Dull green	36.11	1.133	.660	7.775	1.372	.906
	Shiny green	26.28	1.090	1.020	1.595	1.075	1.575
	Greenish yellow	20.40	.850	.360	1.292	1.015	.728
	Average	27.596	1.026	.680	1.887	1.387	1.067
Lemery Yellow	Dull yellow	57.34	.812	.340	5.373	1.100	.606
	Shiny yellow	50.34	.550	.280	3.233	.766	.500
	Dull green	65.53	.836	.405	7.755	2.267	1.607
	Black	52.49	.381	.106	6.405	1.335	.994
	Average	56.425	.645	.283	5.941	1.367	.926
Muñoz Yellow	Shiny yellow	30.76	.300	.133	2.460	.640	.300
	Brownish yellow	33.40	.200	.101	2.566	.600	.300
	Average	32.080	.250	.117	2.513	.620	.300
Sariaya Yellow	Dull yellow	43.93	.742	.352	2.105	.766	.471
	Shiny yellow	39.80	.300	.200			
	Brownish yellow	40.30	.500	.200	2.105	.766	.471
	Average	41.343	.514	.251			
Urdaneta Green	Dull green	62.38	.864	.150	7.603	.608	.976
Rosales Yellow	Dull yellow	40.35	.900	.350	5.188	1.244	.730
	Shiny yellow	25.63	.500	.275	5.540	1.115	.581
	Average	32.990	.700	.313	5.364	1.179	.655
Aliaga Black	Black	14.57	.834	.608	6.558	2.314	1.715

[a] The young pods did not develop to maturity.

A COMPARATIVE STUDY OF THE EMASCULATOR AND THE EMASCULATOME METHODS OF CASTRATION [1]

ENGRACIO BASIO

WITH ONE PLATE

A new instrument for castrating farm animals called the emasculatome is being used in the United States, Europe and South Africa. This instrument is also known as Burdizzo pincers or forceps and *talage*. According to Fitch (1929) the emasculatome, although very generally used in Europe and South Africa, was not introduced into the United States until late in 1927. Several reports in popular live stock magazines state that the instrument is easy to handle; is a very effective tool for castrating large and small animals; makes possible the castration of a larger number of animals in a given time than by any other method; does not produce external wound, and does not disturb the growth or strength of the castrated animals. In short, it is claimed that it is the best instrument in the market for castration. So far as the writer has been able to determine no extensive investigation is available in the Philippines or elsewhere to substantiate this claim for the superiority of the instrument. Because of this lack it appeared important to determine whether the emasculatome method of castration has any advantage over the ordinary method.

PAST WORK ON THE SUBJECT

Fitch (1929) writing on his experience with the use of the emasculatome claims that the swelling incident to castration usually disappears in from 4 to 5 days in all animals except pigs and old bulls, where the reaction may persist for 10 to 15 days. None of the animals seemed to be at all sick or "off feed" and recovery was prompt with little or no visible shrinkage. This writer further claims that the time for the complete absorption of the emasculated testicles varied from one month in smaller animals to three months in old bulls.

[1] Thesis presented for graduation, 1931, with the degree of Bachelor of Agriculture from the College of Agriculture No. 346; Experiment Station contribution No. 886. Prepared in the Department of Animal Husbandry under the direction of Dr. Miguel Manresa.

Maurer (1930) reports that swelling of the testicles continued from 6 to 14 days and that in young animals a complete atrophy of the testicles was usual, but in older animals a hard mass about the size of a nut could be felt in each shrunken scrotal sac several months after castration by the emasculatome method. Apparently, this author was disappointed with its use with stallions. Working on lambs, Maurer found that no difference in size and uniform degree of flesh could be determined in favor of the Burdizzo forceps.

Souquere (1929) observed that with bulls, the testes remained in the lower part of the scrotum during the first month after castration; later, the cord contracted, then the testes were drawn well up into the upper part of the scrotum and became greatly reduced in size.

Alvarez and Lachos (1928) in their histological examinations of the testes of a horse castrated by the emasculatome method report that the number of interstitial cells had increased and that the seminal epithelium had undergone atrophy without greatly disturbing the vascularity of the testicles.

OBJECTS OF THE PRESENT WORK

The objects aimed at in this investigation were: 1. To secure data on the following points: (*a*) The relative effects of the two methods of castration on the duration of swelling, gait of animals, disposition, color in case of cattle, size of neck in case of cattle and carabaos and sex instincts. (*b*) Time of healing under the emasculator method and the time of complete atrophy under the emasculatome method of castration.

2. To make gross or macroscopic and microscopic studies of the effect of castration by the emasculatome method of castration on goats, the object of which was to secure answer to the following questions: (*a*) What is the direct effect of crushing the spermatic cord on glandular tissue and on interstitial tissue of the testes? (*b*) How long do the mature sperm cells remain viable in the testes after such treatment?

TIME AND PLACE

The work was conducted in the Department of Animal Husbandry, College of Agriculture and the College of Veterinary Science, University of the Philippines and in the neighboring barrios in the municipality of Los Baños, Laguna. The work was begun on May 3, 1929, and closed on February 1, 1931, thus covering a period of 21 months.

MATERIALS AND METHODS OF PROCEDURE

Materials

Animals. In this work, 14 cattle, 14 water buffaloes, 4 horses, and 10 goats were used. Of these animals, 3 cattle, 6 water buffaloes, 3 horses and all the goats belonged to the Department of Animal Husbandry, College of Agriculture; 11 cattle, 8 water buffaloes and 1 horse, through arrangement, were available from the owners living in the neighboring barrios.

Scales. A pit live stock scale was used for weighing the animals.

Equipment. Ropes were used in casting cattle and water buffaloes and for tying the legs together preparatory to the operation. For throwing down and restraining the horses a casting harness was used. For the emasculator method of castration the instruments used were a sharp knife and an emasculator provided with double crushing surfaces. For the emasculatome method of castration an emasculatome was the only instrument used. Three per cent creoline solution and tincture of iodine were used to disinfect the scrotum and instruments for the operation with the use of the emasculator. A pine tar ointment consisting of equal parts of pine tar and cosmoline with a little creoline was applied to the wound as fly repellent. A thermometer was used for determining the temperature of the animals.

Equipment used in the microscopic work. For the microscopic work carried out in coöperation with the Anatomy Department of the College of Veterinary Science the following were used: Dissecting set, reagents, receptacles, paraffin, oven, lamp, microtome, slides, cover glasses, compound microscope, and camera lucida.

Procedure

Department animals. The animals were run in pairs, one to be castrated by the emasculator and the other by the emasculatome method.

The animals were fasted at least 15 hours before castration. Just before the operation the weight and temperature of each animal was taken. Observations on the size of the testicles of the animals castrated by the emasculatome method, size of neck in cases of cattle and water buffaloes, color in case of cattle, and disposition in all animals were recorded.

In the emasculator method of castration the animal is thrown down and hogtied. That is, when the animal is properly restrained with ropes, one man holds down its head and another the ropes tied

around the legs away from the operator; then the animal is ready for the operation. The scrotum is washed with creoline solution. With a sharp knife a cut is made through the scrotum and tunica vaginalis into the testes, the wound being large enough for the testes to pass out. The tip of the scrotum having been removed, the knife is struck through the tunica vaginalis parietal layer to the testis until it is exposed. The tunica vaginalis parietal layer, at the point where it connects with the mesorchium, is cut with a knife, freeing the spermatic cord from the connective tissue which might present difficulty when the emasculator is applied. The testis is then pulled out gently while the mesorchium is being pushed inward and the emasculator is applied. The emasculator is kept pressed on the spermatic cord for from two to four minutes to minimize the loss of blood. After the emasculator has been removed and the blood wiped off, the wound is painted with tincture of iodine and then the fly repellent is smeared over and around the wound.

In the emasculatome method of castration the animal is thrown down, but, excepting the horse which is hogtied, the fore legs and the hind legs are separately tied together. In preparing the animal for operation one man holds down its head, another the rope tied around the fore legs, and the third the rope tied around the hind legs towards the rear, thus allowing the operator ample space for action. For a right-handed man it is very convenient to lay the animal on its left side. There is no necessity for cleaning or disinfecting the scrotum before the operation. First, the left testis is grasped, then with a little pulling it is drawn against the apex of the scrotum so as to allow a little pulling of the testis when the spermatic cord has been crushed by the emasculatome. With the thumb, index finger and middle finger of the left hand the cord is pushed towards one side. With the right hand the opened instrument is now applied above the fingers of the left hand. Resting one of the levers on the ground, the instrument is closed by pressing the other lever downward gradually but firmly. When sure that the spermatic cord is caught between the jaws of the emasculatome the testis is pulled to effect a complete separation or a crushing of the cord. In like manner the right cord is crushed. It will aid in preventing leaving one cord uncrushed if the operator crushes left cord first, then right cord, or if he prefers, the reverse. The point is, follow the same order. No fly repellent is applied on the scrotum except when a bruise is made, which sometimes occurs in the operation on older animals.

The emasculatomized animals were placed under observation and study throughout the duration of the experiment. Weights were taken at the time of the operation, three days later and again after four days. After this period of seven days, weights were taken weekly for one month and then monthly for at least one year. The temperature was taken of the first few animals castrated by either method, but as there was no appreciable increase in any case this observation was discontinued. The animals paired were subjected to practically the same care and treatment during the experiment. All the animals were kept under the usual conditions on a Philippine farm.

Animals owned by people living near the College Campus. The same general procedure used with department animals was followed with the outside animals, except that these animals were cared for by their owners. Weighing of these animals was discontinued 6 months after the operation.

Animals belonging to farmers not living near the College Campus. With these animals no weights were taken. Other observations were recorded, but not as often nor as regularly as with the animals belonging to the department or to the people living near the Campus.

Microscopic studies on goats. In these studies, goats ranging in age from 4 to 9 months were used. One goat was used as control, that is the testes were removed just after it was castrated by the emasculatome method; the crushing effect of the instrument on the spermatic cords was observed, and sections taken for microscopic study. The nine remaining goats were first castrated by the emasculatome method. Then the emasculator was employed in removing the testes. The testes of the goats were taken out at the following intervals after operation: 3 days, 7 days, 14 days, 1 month, 2 months, 3 months, 4 months, 5 months, and 6 months. The testes were examined macroscopically and microscopically for the presence of viable spermatozoa. At least two blocks of about one centimeter cube in size were cut out for micro-sectioning. Slides were examined under the microscope using both low power and high power. Then drawings were made under camera lucida.

Before and after castration by the emasculatome method, the scrotum of each goat was measured. Measurements of length, circumference, width, thickness of the left half and of the right half of the scrotum were taken daily for two weeks and weekly thereafter. The preparation of the micro-sections and the studies there-

on were carried out in coöperation with the Anatomy Department of the College of Veterinary Science under the immediate direction of Dr. Manuel D. Sumulong.

RESULTS OF THE EXPERIMENT

The data on the relative effects of the emasculator and the emasculatome methods of castration in cattle as to duration of swelling, gait, disposition, color, size of neck, and sex instincts are shown in table 1. With water buffaloes the effects of the two methods of castration on duration of swelling, gait, disposition, size of neck and sex instincts are shown in table 2. Table 3 gives the observations on the effects of the two operations on duration of swelling, gait, disposition, and sex instincts in horses. Table 4, shows the observations on the healing time in cattle, water buffaloes, and horses castrated by the emasculator method. Table 5 shows the time required for complete atrophy of the testes in the three kinds of animals castrated by the emasculatome method.

DISCUSSION OF RESULTS

Duration of swelling, gait, disposition, color, size of neck, and sex instinct under the emasculator and the emasculatome methods of castration

By the term, "duration of swelling," as used in this paper is meant, in either method, the length of time the scrotum presents an enlarged condition.

Cattle. Table 1 shows that with cattle castrated by the emasculator method, the average duration of swelling was 12 days, the shortest duration being 7 days and the longest, 20 days. With animals castrated by the emasculatome method, the average duration of swelling was 22.6 days, the shortest being 10 days and longest, 35 days. In both methods the swelling was of longer duration with the older animals.

The gait of the animals castrated by the emasculatome method was less affected than with those castrated by the emasculator method. In the emasculatome method of castration, two-year old animals or younger did not show any change in the way they walked or moved about. In both methods of castration the younger the animal the less was the effect on the gait.

The data show that the animals castrated by the emasculator method suffered a greater degree of shock from the operation than those castrated by the emasculatome method. The animals were either excitable or in an irritable state or both for an average of

10.7 days when castrated by the emasculator method and 4.9 days when castrated by the emasculatome method. In either operation the shock to the older animals seemed greater than with the younger ones.

The change in color for animals castrated by either method was marked for practically the same length of time. In younger animals, however, the change in color took place a little sooner than with the older animals. The following transformations of color were observed: black to dark; yellow to whitish yellow; red mixed with dark hairs to scarlet; mottled color to whitish yellow. These colors when present at the tail and shanks did not change appreciably. White and gray colors did not change.

The change in the size of neck was not noticed in young animals where no development had taken place; nor in older animals that were thin and out of condition. With animals whose necks were well developed, either method of castration caused a partial diminution after about two months. With Nellore grades the size of the humps also decreased. Some farmers believe that the reduction in size of the neck does not handicap their work bullocks in strength and endurance.

The emasculatome method of castration is as effective as the emasculator method in destroying sex instincts in cattle. Actions and behavior of the eight cattle castrated did not seem to manifest sex desire.

Water buffaloes. As may be seen in table 2 the average duration of swelling with water buffaloes castrated by the emasculator method was 7.6 days, the range being 2 to 18 days. It may be noted that 18 days, the maximum duration of swelling, is twice as long as the next longest duration, which was 9 days. In this particular case the prolonged duration of swelling was due to maggot infestation of the wound, which necessitated the casting of the animal, picking out the maggots and applying a chloroform pack to the affected parts. With animals castrated by the emasculatome method the average duration of swelling was 37 days, the minimum, 21 days and the maximum, 47 days. The duration of swelling was shorter with younger animals.

With animals castrated by the emasculator method, two did not show any change in gait; the others varied from 1 to 10 days. With animals castrated by the emasculatome method, the period before return to normal gait varied from 6 to 16 days. One animal showed no change of gait.

In both methods of castration the duration of irritability and excitement seemed to vary with the degree of tameness or wildness of the animal. The tame animal returned to normal disposition earlier than the wilder one. The animals castrated by the emasculatome method showed greater effects from shock than those castrated by the emasculator method. This may have been due to the fact that the spermatic cords of water buffaloes are relatively larger and shorter than those of cattle, and the skin covering is thicker. The effect of the emasculatome was such that the testes were drawn close to the body upward and the swelling was so marked that a slight motion caused a rubbing of the injured parts against the inside of thighs of the animal. This continual irritation undoubtedly tended to make the animal ill-tempered.

As with cattle, decrease in size of neck in water buffaloes was discernible in animals with fully developed necks. With animals castrated by the emasculator method the decrease in size of the necks was noticed as early as 1 month and as late as 2 months; with animals castrated by the emasculatome method the average was 2 months. When the neck was fully developed before castration, a similar condition was noted in water buffaloes as in cattle, that is, neither method of castration effected much change.

With water buffaloes, the sex instincts disappeared entirely soon after castration by the emasculator method. With animals castrated by the emasculatome method not as good results were obtained. Of the 5 animals castrated by the emasculatome method 3 were observed to lose their sex instincts outright. One animal, about 2 years, 9 months old, continued to show sex instincts for one month. Another, about 4 years of age, was observed to cover females and fight with other carabao bulls for about 8 months after castration. None of the females covered, however, has as yet shown conception incident to these services.

Horses. With the horse castrated by the emasculator, the duration of swelling was 12 days and the sex instincts were lost soon after castration. Its gait returned to normal after 5 days and its disposition within 10 days.

With the 3 horses castrated by the emasculatome the one 9 months old suffered swelling for 4 days; of the other 2, one for 36 days and one for 40. None of the three showed any change in gait and disposition as a reaction to castration. While the younger horse which had not matured sexually at the time of operation did not, of course, show sex desires after, one of the other two horses did continue to

show its sex instincts for several months after the operation. Horse No. 2 had to be recastrated by the emasculator after one year for it was repeatedly noticed to cover mares. This horse showed upon castration by the emasculator testicular tissues which were normal. In fact, microscopic examination of smears taken from these normal tissues showed the presence of living spermatozoa. Further details of this result are given elsewhere in this paper.

Weights of animals castrated by the emasculator and the emasculatome methods

Cattle. The mature animals paired differed by 70 kilograms in weight but they were of about the same age and condition, and were used to about the same care and farm work. The young animals paired differed by 6 kilograms in weight, were about the same in age, condition and care. The weight curves of the young pair differed little up to 2 months after castration. Later, while the animal castrated by the emasculator method steadily grew, the other animal decreased in weight before it resumed its growth at a lower rate. The animal castrated by the emasculatome had greater shrinkage in weight and regained weight later than the one castrated by the emasculator method. After 1 month, the weight curves of the 2 animals were about the same.

Water buffaloes. Two pairs of water buffaloes were used. Of the first pair, the animal castrated by the emasculator method decreased in weight and required 1 month to regain the loss. The other animals, on the other hand, did not suffer shrinkage, instead their weight curves went on unaltered. After 1 month, the rates of growth of the animals were fairly even. There was a slight difference in favor of the emasculatome in that the animal castrated by the emasculatome method lost less weight after the operation than the one castrated by the emasculator method. In their growth curves later there was no significant difference.

Time of healing under the emasculator method of castration and the time of complete atrophy under the emasculatome method

The phrase, "time of healing", in this paper is used to mean the period between the date of the operation to the date when the wound was completely closed.

Cattle. With cattle castrated by the emasculator method the healing time ranged from 14 to 25 days, with an average of 20.8

days, as shown in table 4. The data show that healing took place with younger animals in a shorter time than with older animals. Table 5 shows that of the 8 animals castrated by the emasculatome method, complete atrophy of the testes took place in 75 per cent of the number, the shortest time being 7 months and the longest, 14 months. These changes were observed in animals 1 to 3 years of age. The other 2 animals at the close of the experiment still showed signs of incomplete atrophy of the testes. These findings would seem to be contrary to those reported by Fitch (1929) who claimed that complete absorption occurred in from one month with the smaller animals to three months with old bulls. It is quite possible, however, that a variability in the time of complete absorption occurs in animals of the same species but in different environment.

Water buffaloes. As may be seen in table 4 the minimum healing time with water buffaloes was 8 days and the maximum, 25 days, the average healing time being 14.6 days. As was the case with the cattle, healing was faster with the younger water buffaloes than with the older ones. With the animals castrated by the emasculatome method, complete atrophy of the testes took place within 15 months in one animal that was 3 years old. The scrotum of the other animals at the close of the experiment showed indications of the presence of testes which were still undergoing degeneration

Horses. With the only horse castrated by the slit method, complete healing took place within 23 days. In only one horse (9 months old) of the three castrated by the emasculatome method were the testes completely atrophied. This was observed 7 months after castration, as shown in table 5. Horse No. 2 had to be recastrated by the emasculator method one year later. It was found that the testes had partially degenerated. The left testis the cord of which was completely crushed was smaller than the right one the cord of which was only partially crushed. Microscopic examination revealed the presence of viable spermatozoa in the right testis. To these spermatozoa was attributed the persistent manifestation of sex instincts after castration by the emasculatome. The same case was apparently true, although not so well marked, with horse No. 3. At the latest observation, one year after this animal was castrated by the emasculatome method, the testes were partially degenerated. The left testis had degenerated to a size smaller than an average hen's egg and the right testis was about twice as large.

Macroscopic and microscopic studies on the effect of castration by the emasculatome method

Effect of crushing the spermatic cord on the glandular and interstitial tissues of the testis. Observations, so far made, on the effects of castration by the emasculatome method were on the external body features and behavior of the animals castrated. These observations may not warrant a conclusion as to how good and how effective the instrument is in sterilizing farm animals. To remove any doubt regarding efficiency of the instrument, macroscopic and microscopic studies were conducted on the testes of sexually mature goats. These goats were emasculatomized and after varying intervals of time their testes were removed to be studied macroscopically and microscopically.

As to the efficiency of the instrument in crushing the spermatic cord, examination of the testes removed from the ten goats castrated by the emasculatome method showed that the spermatic cord was completely crushed. The cremaster muscles and most of the blood vessels and nerves were cut. The rest of the blood vessels and nerves were either partially cut or crushed. The vas deferens was likewise crushed, but never completely severed. Blood clots filled the place of injury. The mesorchium in most cases was never severed. The testes began to degenerate usually 10 days after emasculatomization when swelling had subsided. Blood had hardened in the veins and capillaries of the testes. The glandular substance and interstitial tissues were discolored, the extent of discoloration varying with time. With the testes removed, after 7 days the depth of the bluish discoloration from the surface of the testes was about 1.5 centimeters. With the testes removed, 6 months after castration the colors of the glandular and interstitial tissues from without inward were yellow and pale white and the texture became friable and rather firm to touch. These conditions deviate much from those in the normal state when the gland substance is soft and reddish gray in color.

The slides showed that in some cases the convoluted tubules had undergone diminution in size accompanied by the widening of the inter-tubular spaces. In most cases no reduction in size of convoluted tubules but widening of inter-tubular spaces occurred. The lumena of the tubules were generally not discernible after 14 days. Within two months, nuclei in the parenchyma of the tubules disappeared. The sections seemed to show that atrophy of the testes is not associated with continuous decrease in size of the tubules until they are finally resorbed. Apparently, atrophy in this case is the decrease

in size of the tubes, widening of the inter-tubular spaces and contraction of the interstitial tissues to such an extent that the tubules begin to disintegrate. The sections from the testes removed six months after emasculatomization showed that the disintegration of the tubules takes place either from outside or inside or by both ways at the same time. It was noted that in some sections the walls of the tubules were broken, in others, the germinal epithelium was not continuous; it tended to split into several parts; while in other sections the disintegration was apparent from both outside and inside.

Of the sections made, the effect of the emasculatome upon the interstitial tissues first becomes apparent in these from the testes removed 3 days after the operation. The interstitial tissue begins to withdraw from the walls of the tubules. In 6 months the interstitial tissue was well contracted in the already widened inter-tubular spaces; in some parts it was reduced to a thin-threadlike structure. These histological findings are in agreement with those reported by Retterer (1928) who worked with bulls. He found complete absence of Leydig cells in the interstitial tissue. Alvarez and Lachos (1928) working on the histology of the testes of a horse castrated by the emasculatome method reported an opposite result. They found the greater number of the cells of Leydig in the interstitial spaces. Atrophy of the seminal epithelium occurred without greatly disturbing the vascularity of the testicles. It is quite possible that these workers may have been dealing with slips, although the different species may show such a difference.

The testes removed 5 months after castration were so atrophied that the section made from what appeared to be the remnant of the testes did not show any trace of gland substance, but showed cells of the epididymis.

Viability of mature sperm cells after castration by the emasculatome method. To determine the presence of living spermatozoa in the testes of animals castrated by the emasculatome method, smears were taken from the glandular substance of the testes, epididymis and vas deferens immediately after the removal of the testes. These smears were diluted in physiological salt solution and centrifuged before they were examined under the microscope. Microscopic examination showed that the viable spermatozoa were present in testes removed 3 days after emasculatomization. A few spermatozoa were also observed after 7 days but they were apparently weak. In all other testes removed later no spermatozoa could be found. This experiment yielded results much different from those of an experiment which Quinlan (1928) carried out with vasectomized sheep in whose

testes he observed, that spermatogenesis continued to take place at 12 months and up to 30 months after vasectomy. It should be noted, however, that in vasectomized animals the blood vessels and the nerve supply of the testes are not disturbed. In vasectomized males only the vas deferens is cut. In the emasculatomized animals the blood vessels and nerves, together with the muscles, that are inclosed in the cord are completely crushed thereby depriving the testes of their nutrition and nerve supply.

Practicability of the emasculatome method of castration

Cattle. With cattle, the emasculatome is a practical instrument for castration. Especially is this true on ranches where many bull calves not needed for breeding purposes have to be castrated in the shortest time possible. This method of castration can be used any time of the year in any place and under unfavorable conditions, as rainy weather, prevalence of tetanus infection, and of blow flies. The instrument has been proved effective in sterilizing cattle. The animal is not greatly inconvenienced and the young animals do not generally go "off-feed." Although the handling of the instrument seems simple, precision in its use is most important. In the operation one should always be sure that both cords are thoroughly crushed, if not severed. Contrary to the practice of castrating the animal while standing, as is in vogue in the United States and France as reported by Fitch (1929) and Maurer (1930) and Souquere (1929), the writer suggests that animals be cast for the operation. The extra trouble of restraining the animal in this way will be more than compensated for by the higher percentage of success. After the instrument is closed over the spermatic cord, a little pulling of the testes away from the grip of the instrument will cause complete separation of the cord. It is a good practice to crush one cord at a time.

Water buffaloes. With carabaos up to 2 years of age the instrument can well be used. But with older animals the use of the emasculatome becomes more an instrument of torture than of utility. The closing of the instrument over the spermatic cord requires the strength of at least two men. Although the crushing of the cord is effected, the operation usually makes a break in the skin. This condition defeats the secondary purpose of the instrument, in that it exposes the animal to secondary infection. It seems possible, however, to modify the instrument so that it could be used for carabaos over 2 years old. The most important modifications suggested are a wider gap between the jaws and a longer handle to increase leverage advantage.

Horses. The writer does not feel justified in making any general conclusion as to the use of the instrument with horses as the cases used in this study were very few. However, some statements can be made on its use with this animal:

1. The emasculatome can not be used by an inexperienced man in castrating horses.

2. It can be used with some difficulty, however, by an experienced man with young animals and with less difficulty with older ones.

3. The emasculatome is a safe instrument for castrating horses because, as a rule, there is no severe injury on the skin, thereby reducing the possibility of infection, such as tetanus.

4. The important thing in castrating horses is to be sure the spermatic cord is completely severed.

SUMMARY AND CONCLUSIONS

1. The emasculatome method of castration was found to be as effective as the emasculator method of castration for cattle and goats of all ages and water buffaloes up to 2 years of age.

2. Complete atrophy and resorption of the testes took place in 9 months with young animals; the time was much longer with older animals. Time required for absorption of the testis varied directly with its size.

3. One method had no decided advantage over the other on the growth of animals, although the animals castrated by the emasculatome method suffered less shrinkage than those castrated by the emasculator method.

4. Duration of swelling was much longer with animals castrated by the emasculatome method than with animals castrated by the emasculator method. Duration of swelling was generally less with younger animals than with older.

5. With animals castrated by the emasculatome method, change in gait was not associated with the duration of swelling.

6. With cattle, the emasculator method of castration was more painful than the emasculatome method. The reverse was true with water buffaloes.

7. Both methods of castration effected change in color of cattle in practically the same length of period. Change took place a little earlier with younger animals. With young cattle and water buffaloes, either method caused decrease in size of neck, but less with older animals where the neck had fully developed.

8. Average healing time under the emasculator method was about 21 days with cattle and 15 days with water buffaloes. Healing time was generally shorter with younger animals.

9. Microscopic studies showed that in properly emasculatomized goats the testes were incapable of producing spermatozoa 7 days after emasculatomization.

10. The glandular substance and interstitial tissue of the testes of goat were practically dead 2 months after emasculatomization.

11. The data on horses are not conclusive, but there are indications that the instrument cannot be handled by inexperienced men with success, owing to possibility of incomplete crushing of the spermatic cord and therefore incomplete castration.

12. The castration by the emasculatome method is simple, quick, and safe, but should be executed with a proper technique to be effective.

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TABLE 1

Showing the relative effects with cattle of the emasculator and the emasculatome methods of castration on duration of swelling, gait, disposition, color, size of neck, and sex instincts

Animal No.	EMASCULATOR METHOD						Animal No.	EMASCULATOME METHOD					
	Duration of swelling	Return to normal gait	Change in disposition to normal	Change in color	Change in size of neck	Change in sex instincts		Duration of swelling	Return to normal gait	Change in disposition to normal	Change in color	Change in size of neck	Change in sex instincts
	days	*days*	*days*	*mo.*	*mo.*	*mo.*		*days*	*days*	*days*	*mo.*	*mo.*	*mo.*
1	7	2	1	1.5	0	0	1	10	0	1	1.5	0	0
2	9	4	3	2.0	0	0	2	15	0	2	2.0	0	0
3	10	5	5	2.0	2	0	3	20	0	10	2.0	0	0
4	14	5	11	2.0	2	0	4	23	0	5	2.0	0	0
5	13	4	19	2.0	2	0	5	15	0	2	2.0	0	0
6	20	8	25	2.0	2	0	6	33	4	5	[a]	0	0
							7	30	3	7	2.5	2.5	0
							8	35	3	7	2.0	1.5	0
Av.	12.0	4.7	10.7	1.9	—	0	Av.	22.6	—	4.9	2.0	—	0

[a] When the color was gray at the time of castration it did not change.

TABLE 2

Showing the relative effects with water buffaloes of the emasculator and the emasculatome methods of castration on duration of swelling, gait, disposition, size of neck, and sex instincts

Animal No.	Emasculator method: Duration of swelling	Return to normal gait	Change in disposition to normal	Change in size of neck	Change in sex instincts	Animal No.	Emasculatome method: Duration of swelling	Return to normal gait	Change in disposition to normal	Change in size of neck	Change in sex instincts
	days	*days*	*days*	*mo.*	*mo.*		*days*	*days*	*days*	*mo.*	*mo.*
1	2	0	0	0	0	1	35	14	27	1.0	0
2	7	1	5	0	0	2	21	0	35	1.5	1
3	5	1	5	0	0	3	42	16	30	2.0	8
4	8	2	20	2.0	0	4	47	6	6	3.0	0
5	6	7	7	1.5	0	5	40	15	58	2.0	0
6	7	0	12	2.0	0						
7	18	4	4	1.0	0						
8	6	10	9	1.5	0						
9	9	6	6	2.0	0						
Av.	7.6	—	—	—	0	Av.	37.0	—	31.2	1.9	—

TABLE 3

Showing the relative effects with horses of the emasculator and the emasculatome methods of castration on duration of swelling, gait, disposition, and sex instincts

	EMASCULATOR METHOD					EMASCULATOME METHOD			
Animal No.	Duration of swelling	Return to normal gait	Change in disposition to normal	Change in sex instincts	Animal No.	Duration of swelling	Return to normal gait	Change in disposition to normal	Change in sex instincts
	days	*days*	*days*	*mo.*		*days*	*days*	*days*	*mo.*
1	12	5	10	0	1	4	0	0	0
					2	36	0	0	12 [a]
					3	40	0	0	0
Average	12	5	10	0	Average	26.7	0	0	—

[a] Although the testes had been greatly reduced in size this animal continued to cover the mares that were in heat until he was castrated by the emasculator method one year after the application of the Burdizzo pincers. At this time it was found that a small portion of the testes remained functional. In fact, microscopic examination revealed motile spermatozoa in the right testis.

TABLE 4

The time required for complete healing to take place in different kinds of animals that were castrated by the emasculator method

CATTLE				WATER BUFFALOES					HORSES	
Animal No.	One-year old	Two-year old	Mature animals	Animal No.	One-year old	Two-year old	Three-year old	Mature animals	Animal No.	Mature animals
	days	*days*	*days*		*days*	*days*	*days*	*days*		*days*
1	14	—	—	1	8	—	—	—	1	23
2	—	19	—	2	—	14	—	—		
3	—	—	20	3	—	9	—	—		
4	—	—	23	4	—	12	—	—		
5	—	—	24	5	—	15	—	—		
6	—	—	25	6	—	—	16	—		
				7	—	—	—	25 [a]		
				8	—	—	—	16		
				9	—	—	—	16		
Av.	14	19	23	Av.	8	12.5	16	19	Av.	23
General average—20.8				General average—14.6						

[a] Wound was infested with maggots.

TABLE 5

Showing the time required for complete atrophy of the testes to take place in different classes of animals castrated by the emasculatome method

CATTLE					WATER BUFFALOES			HORSES		
Animal No.	One-year old	Two-year old	Three-year old	Mature animals	Animal No.	Three-year old	Mature animals	Animal No.	One-year old	Mature animals
	mo.	*mo.*	*mo.*	*mo.*		*mo.*	*mo.*		*mo.*	*mo.*
1	9	—	—	—	1	[a]	—	1	7	—
2	—	8	—	—	2	15	—	2	—	[a]
3	—	7	—	—	3	—	[a]	3	—	[a]
4	—	8	—	—	4	—	[a]			
5	—	9	—	—	5	—	[a]			
6	—	—	14	—						
7	—	—	—	[a]						
8	—	—	—	[a]						

[a] At the conclusion of the experiment these animals still showed signs of incomplete atrophy of the testes.

PLATE I

Fig. 2. Testis of goat 5 months old removed 3 days after emasculatomization, × 1.

Fig. 10. Testis of goat 7 months old removed 6 months after emasculatomization. × 1.

Fig. 11. Camera lucida drawing of section from normal testis of a goat 7 months old. × 360.

Fig. 19. Camera lucida drawing of section from testis of a goat 7 months old, 6 months after emasculatomization. × 360.

Fig. 20. Camera lucida drawing of section showing a portion of the germinal epithelium from normal testis of goat 7 months old. × 2160.

Fig. 25. Camera lucida drawing of section showing a portion of the germinal epithelium from testis of a goat 7 months old, 6 months after emasculatomization. × 2160.

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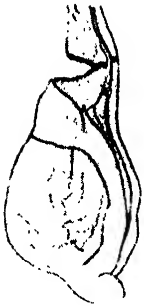

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PLATE I

NOTE: BAKER MEMORIAL SCHOLARSHIP FUND

As the Baker Memorial Scholarship Fund is the result of voluntary contributions given as a tribute to the memory of Charles Fuller Baker, Dean College of Agriculture 1917–1927, it is well to periodically report on it.

In accordance with the recommendation by the original Baker Memorial Committee, the dean, the secretary and the head of a department of this college compose the Standing Baker Memorial Scholarship Committee. This committee on April 10, 1931 reported contributions for 1931 up to that date as ₱103.

On April 7, 1933 the committee reported further contributions as follows:

1931	
Mr. Leopoldo J. Villanueva	₱4.00
Class of 1932	₱11.00
1932	
U. P. Student Council	₱500.00
Mr. Gaudencio Reyes	₱10.00
Dr. M. Manresa, Chairman Social Affairs, C. A. (Surplus of Christmas Fund)	₱6.29
1933	
Student Body, College of Agriculture	₱30.00

With these additional contributions the Fund on April 7, 1933 was ₱2,764.29.

The aid from this fund has been awarded as follows: 1929-30 to Ambrosio V. San Pedro, now assistant in agronomy; in 1930-31 to Engracio Basio, now assistant in poultry husbandry; in 1931–32 the award was divided between Juan Padilla, now in charge of Elizarde poultry projects in Baguio and to Marcelino G. Canlas. In 1932–33 the aid was again divided and awarded to Proceso Alcala and to Filomeno Butac.

According to the prescribed conditions of this scholarship, it is awarded to a self-supporting student or students of the senior class; the selection is made "on the basis of character, promise of future usefulness and scholarship." The amount awarded this year to each

of the Baker Scholars was ₱63; though a small amount yet a welcome help to a young man who supports himself on the wage of 10 to 14 centavos an hour, the current rate on the Campus.

The Fund is always open to contributions, large or small. Contributions may be sent to the Dean, College of Agriculture, and Mr. Alfredo V. Yñiguez, the Chief Clerk and Disbursing Officer will transmit them to the Treasurer of the Fund, the Secretary of the University of the Philippines. Each increase in the Fund increases the interest, hence increases the amount of the award. It is gratifying to note the generous contributions from student organizations. Money given to the Baker Memorial Fund each year gives comfort and cheer to one or more students; may help to relieve a burden which might otherwise become too heavy to be borne. Surely a better investment of funds than in a banquet which lasts but an evening.

NOTE: THE SECOND RURAL LIFE INSTITUTE

The second Rural Life Institute was held under the auspices of the National Christian Council and the College of Agriculture from March 27 to April 1, 1933. This year's institute registered 45 (37 men and 8 women) delegates representing 22 provinces; last year there were 36 (28 men and 8 women) delegates from 18 provinces. The delegates to this Institute came from regions as widely separated as Cagayan in the north and Lanao in the south. Among the delegates were pastors, missionaries, students, laymen, teachers in training schools, and clerks.

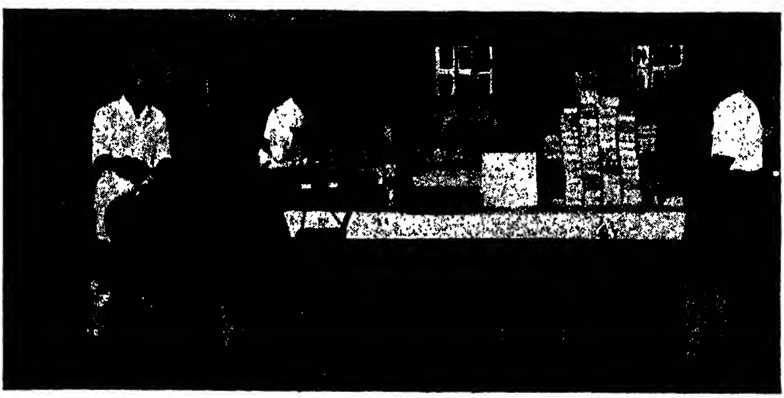

Fig. 1.—Showing process of making soap at home using coconut oil. Lecture, by Dr. P. David.

About five hours a day were devoted to lectures, demonstrations and discussions under direction of members of College faculty. In addition there were Round Table discussions conducted by the leaders in the Institute and one formal address each day on a general topic by a guest speaker.

The scope of the agricultural work is indicated by the following program.

March 27—(1) Plant propagation. (2) Food preservation. Dr. L. G. Gonzalez.

March 28—(1) Poultry raising for profit. Dr. F. M. Fronda.
(2) Caponizing—actual operation performed by delegates under direction of Mr. Engracio Basio.

March 29—(1) Hog raising. (2) Castration of pigs. Dr. M. Mondoñedo.
(3) Good types of farm animals. Dr. V. Villegas.
(1) Selection of varieties and seeds. Dr. N. B. Mendiola.
(2) Uses and preparation of products from different permanent farm crops products. Dr. P. David.

March 30—(1) Uses and preparation of products from annual farm crops. Mr. Vicente Aragon.
(2) Useful hints in vegetable growing including the raising of onions. Dr. L. G. Gonzalez.
(1) Farm sanitation. Construction of Antipolo types of toilets. Dr. A. L. Teodoro and Prof. A. B. Catambay.

March 31—(1) Some common insect pests, and their control. Dr. L. B. Uichanco.
(1) Some common plant diseases and their control. Dr. G. O. Ocfemia.
(1) Fertilization and manuring. Dr. R. B. Espino.
(1) Cheese making. Dr. F. B. Sarao.

April 1. Balanced diets of Filipino food. Preparation of balanced meals from native materials, such as rice, fish, vegetables; cost and food values. Dr. F. O. Santos.

Fig. 2.—Samples, mostly raw, of balanced meals from native products, used by Dr. F. O. Santos in lecture on balanced diets of Filipino food. The rice part is not shown. Upper horizontal column shows breakfasts; middle and lower horizontal columns, lunch or supper.

The lectures and discussions were made as practical as possible. Demonstrations were used freely.

The prepared products from farm crops were shown. The food for balanced meals was shown not as a whole, but the food for the different meals which would give a proper diet.

The delegates manifested genuine enthusiasm in all the subjects and demonstrations presented by the College of Agriculture faculty. A large number of the facilities of the Departments of the College which gave lectures and demonstrations were placed at the disposal of the delegates thus making their six-day sojourn on the Campus interesting as well as profitable.

In the closing meeting of the Institute resolutions were voted by the delegates expressing cordial appreciation of the courtesy and the valuable instruction received from the faculty of the College. and also expressing gratitude for the kindly hospitality extended by Rev. and Mrs. Hugh Bousman of the Evangelical Christian Center.

MANUEL R. MONSALUD
Of the Department of Agronomy

NOTE: GIFTS FROM U. P. STUDENT COUNCIL

In the past two years the U. P. Student Council has done notable work on the Campus through their donations. In 1930–1931, ₱2000 was appropriated by the Council as a gift for the construction of a gate at the entrance to the grounds of the Associated Colleges. This gate is still in process of construction. In 1931–1932, ₱500 was appropriated by the Council for the construction of cement seats to be placed on the Campus. These seats which are of the popular model for College campuses and parks add beauty to the Campus and give much comfort to the students, college residents and excursionists. During this same year, ₱500 was donated to the Baker Memorial Fund of the College of Agriculture. In 1932–1933, ₱800 was appropriated by the Council for the construction of a statue, to be placed just within the Campus Gate.

The sources of all these appropriations is from the 50-centavo U. P. Student Council semestral fee collected from each U. P. Student.

The Associated Colleges of Los Baños wish to express their hearty thanks to each U. P. Student, and especially to the U. P. Student Council for these generous gifts of permanent value. It reveals a fine spirit of interest in civic welfare.

CURRENT NOTES

Taking as its discussion topic "Adult Education and Rural Life," the American Country Life Association meeting at Oglebay Park, Wheeling, W. Va., October 13–15, 1932, viewed this question from many different angles in the various forum sessions and general meetings. The objectives of existing agencies were analyzed and modifications suggested. A well-balanced local program of rural adult education, it was held, should provide not only vocational guidance and training that will enable farm men and women to take effective adjustments to changing economic conditions and to discoveries in the natural science, but will also furnish the basis for more stimulating cultural, social, and recreational activities. The need for greater coordination among the agencies operating in this field as a means of avoiding duplication and conflict, and of filling in the gaps received considerable attention.

Journal of Farm Economics, January, 1933

As eggs are also a good source of supply of all the other vitamins except C (which is present in oranges, lemons, tomatoes, and other fruits) it is all the more important that their value should become generally known. Milk and milk products are not so rich nor so certain a source of vitamins as eggs....

Every child should have both his egg and his apple daily (or a tomato instead), as well as his milk allowance.

The Farmers' Gazette, October 8, 1932

The price of Maguey from Cebu in the Philippines fell off as producers had little incentive to strip and prepare the fibre at current values. This caused supplies to be irregular, so spinners turned to sisal. With Davao fibre, on the other hand, interest is said to be broadening in this well-prepared fibre, and when trade revives it is safe to predict that its consumption will rapidly increase. Where it has been adopted it gives universal satisfaction owing to its careful preparation and great strength.

Tropical Life, February, 1933

Our backwardness in commerce and industry is largely attributed to our lack of organization and cooperation among ourselves. Our meagre participation in any line of commercial activities is too patent to need any comment. Taking these facts as our beacon light, the bureau of commerce and industry has adopted as one of its main projects for the present year the establishment and organization of trade promotion associations in important provincial centers.

Commerce and Industry Journal, Philippines, April, 1932.

Rice in Austria. Experiments in rice-growing have met with success in Central Europe. Good rice in satisfactory quantities is reported to have been yielded by marshy land in Hungary, and it is now intended to open an experimental area for rice cultivation in a nearby district of Austria. During the coming spring rice is to be grown on the borders of the Neusiedlersee Lak, according to an announcement by the Agricultural Chamber of the Burgenland, a district on the border of Austria and Hungary. The slime in this area contains salt, and is therefore expected to prove suitable for the growing of rice.

The Madras Agricultural Journal January, 1933
(Reprinted from the "*Statesman*" Jan. 20, 1933)

Much of the increased interest in agriculture being shown by the rural youth of today is due in a large part to the educational program being carried on by the 4-H clubs and Future Farmers organizations. These organizations have among their purposes the promotion of education in agriculture; the creation of more interest in the choice of farming as an occupation; and the creation of a love for rural life....

In view of the benefits derived from these organizations, it is desirous not only to continue the cooperation of the schools, societies and agricultural departments of the state, but to further it so that the worth-while work of these organizations may be carried on in a larger way and to a better advantage.

The Purdue Agriculturist (Purdue University) February, 1933

Never allow ducklings to sleep on damp or wet bedding, as this is a common cause of leg weakness, and once a duckling becomes affected in this way little or nothing can be done for it. It is really

a matter of prevention by checking everything that tends to create a moist atmosphere. The first essential to this end is to place the water-vessels well away from the sleeping-quarters, so as to prevent the bedding-materials from getting wet.

Young ducklings should be always protected from hot sun, as they have thin skulls and are very prone to sunstroke, which is a common cause of heavy mortality. Good shade is the secret for preventing this trouble.

N. Z. Journal of Agriculture, Aug. 20, 1932

COLLEGE AND ALUMNI NOTES

Mr. E. D. Hester, American Trade Commissioner, formerly Head of Department of Economics and College Registrar gave the Commencement Address at the graduation exercises of the Rural High School on March 17.

The Associated Press dispatches of March 6 carried the sad news of the death of Mr. Edgar M. Ledyard, agricultural director for the United States Smelting Company, Salt Lake City, Utah. Mr. Ledyard was on the faculty of the College of Agriculture from 1911–1914, being the first instructor in entomology.

Dr. and Mrs. W. J. Simpson from the Changli Mission near Peitaho, China, spent a week at Copeland House in February. Doctor Simpson is in charge of the agriculture and fruit culture work in this mission, hence found the College and Forest School nurseries of great interest, and Maquiling a never failing source of beauty and pleasure and of course, information.

Dean Gonzalez recently received a letter from Mr. Sam B. Durham, who was the first professor in animal husbandry in this College. We quote from the letter:

"I want to take this opportunity of thanking you for the publications which you have forwarded. They have furnished me no small amount of genuine interest. I congratulate you personally upon the success you have made of the work in your charge. Our director is making a study of the memorial publication—I can assure you that I think Dr. Baker was the greatest man I have ever known.

"How I would enjoy returning and trying out some permanent pastures in that country! I am more of a permanent pasture specialist now than anything else."

Mr. Durham is now District Dairy Agent in the coöperative extension work in agriculture in Oklahoma. The coöperating factors are Oklahoma Agricultural and Mechanical College and United States Department of Agriculture.

Dr. A. I. de Leon in the sixth travelogue took his audience to Oberammergau to the 1930 performance of the famous Passion Play. The many pictures in color supplemented by Doctor de Leon's graphic description made the play which in 1934 will have been given in this mountain village for four hundred years very real. The journey with the speaker from Berlin to Oberammergau made an interesting prologue, especially the visit to the world famous Munich Museum.

On the evening of February 4, the audience in the seventh and last travelogue of the year spent an hour or more on Jersey Island under the guidance of Dr. Miguel Manresa. If Doctor Manresa had as merry a time during his stay in this home of the Jersey cow, as he gave his audience, it might be recommended as a place to go for a cure for the blues.

The eightieth meeting of the Los Baños Biological Club was held on Thursday, January 26, 1933, at 7:30 p. m. in the Poultry Husbandry lecture room of the College of Agriculture.

The following papers were read and discussed:

1. "Chemical Control of Sap-stain and Mold in Green Lumber and Logs" by Ranger Ricardo Buhay.
2. "An Investigation on the use of Phosphoric Acid for Inversion in Sugar Analysis" by Mr. Florencio A. Soliven.
3. "A Comparative Study of the Emasculator and the Emasculatome Methods of Castration" by Mr. Engracio Basio.

The eighty-first meeting of the Los Baños Biological Club was on Thursday, February 16, 1933, at 7:30 p. m. in the Poultry Husbandry lecture room.

The following papers were read and discussed:

1. "An Evidence Relating to the Transmissibility of the Fiji Disease of Sugar by an Insect Vector."

   By Dr. Gerardo O. Ocfemia.

2. "Studies on the Comparative Effects of the Duration of Direct Sunlight in the Establishment of Plantation of Camagong (*Diospyros discolor* Willd.)."

   By Ranger Nicanor P. Lalog.

3. "The Food of the Male Inmates of Bilibid Prison."
By Dr. Francisco O. Santos and
Mr. N. A. Pidlaoan

The eighty-second meeting of the Los Baños Biological Club was held on Thursday, March 9, 1933, at 7:30 p. m. in the Poultry Husbandry lecture room of the College. The following papers were read and discussed:

1. "Collection and Care of Philippine Orchids."
By Ranger Mamerto D. Sulit.

2. "Chemical Analysis of the Water Supply in the College of Agriculture."
By Messrs. R. A. Cruz and
R. T. Marfori

On the evening of February 10 at Center the Mimics presented a program of three parts.

Part I was a one act play—"The Pot Boiler" by Alice Gerstenberg.

The cast was:

Sud	Pedro Lorenzo
Wouldby	Romulo Gines
Mrs. Pencil	Numeriano Cuevas
Miss Ivory	Felix Remigio
Inkwell	Rasuman Macalandong
Ruler	Andres Caranto
Mr. Ivory	Laureano Lucas

Part II was a group of songs:

The Soldiers' Chorus (From "Faust" 1859 by Charles Gounod)	Chorus
Rig-a-jig	Chorus
Polly Wolly Doodle	Double Quartette
Quilting Party	Chorus
Drink to Me Only With Thine Eyes (Words by Ben Jonson [1573-1637], melody, old English Air)	Chorus
The Bull Dog	Quartette
Stars of the Summer Night (Words by Longfellow [1840], music by I. B. Woodbury)	Chorus
The Anvil Chorus (From "Il Trovatore" 1853 by Guiseppe Verdi)	Abel Silva and Chorus

Part III was "A Valentine," a *tableau vivant*—Nora Roa was "The Girl in Heart" to whom Jose Quintos with emotional inter-

pretation sang "Little Annie Rooney." In the chorus the love motif was sustained with fervor by the sixteen voices of the male chorus.

Chorus:

1st Tenors	Felix de Leon Flores, Basunie Saropie, Abel Silva
2nd Tenors	Venancio Duarte, Jose Quintos, Federico Paguyo
1st Bases	Martin Rosel, Racine Base, Primo Castro, Celestino Quilang, Federico Reyes, Ladislao Martir.
2nd Bases	Miguel Guzman, Victorio Antonio, Constantino Valero, Flaviano Olivares

Director of Mimics	Miss Anne Cole
Musical Director	Mrs. Hugh Bousman
Accompanist	Mrs. Hugh Curran

The Aggie Pen Club at the close of its second year distinguished itself with issuing *Farm Leaves,* a magazine of 50 pages. The contents are stories, sketches, poems, etc. of a character that would do credit to clubs of longer life and greater sophistication. The format merits high praise, as do the illustrations. The Club and the Adviser, Miss Turner deserve and have received praise of a panegyric quality.

Miss Katherine Turner, instructor in Department of English resigned at close of College year. She spent a month in the Southern Islands before sailing for the Homeland. Miss Laura Mae Williamson, teacher of English in Rural High School resigned and sailed for the United States in April.

The Siamese Students' Association celebrated the Siamese "New Year with a reception and dinner at the Manila Hotel on the evening of March 31. In the Buddhist Calendar, still used in Siam, this was the eve of the New Year, 2476 B. E.

Mr. Getulio Guanzon, a University Fellow in the United States returned to the Islands and reported for duty in Department of Chemistry in February. Mr. Guanzon studied in Louisiana State University and University of Minnesota, receiving a degree of Ph.D. in Agricultural biochemistry from University of Minnesota.

Jose Garcia Villa the Filipino short story writer now in the United States recently wrote the editor of a Manila weekly asking for biographical notes on Jose Quintos '33 who had published short stories under a pen name in this weekly. Mr. Quintos was one of the first group of members of the Aggie Pen Club.

Mr. Pedro Rodrigo '21 B.Agr., '23, B.S.Agr. was a Campus visitor in March. Mr. Rodrigo who was formerly instructor in Agronomy is now with the Bureau of Plant Industry.

Mr. Paulino Menor '26 B.Agr. was on the Campus in March revisiting old loved spots. Since his graduation, Mr. Menor has been in Davao. He is technical adviser with the Furukawa Plantation Company. At the time of his visit he was on a four months vacation. In addition to work with his company where the principal crops are abaca and coconuts, Mr. Menor has a 10 Ha. farm about 40 kilometers from Davao.

The following students received degrees on March 21, 1933.

Ad Interim

Bachelor of Science in Agriculture

1. Telesforo Tioaquen (June)
2. Honorio L. Ylizarde "
3. Francisco P. Franada "
4. Moises G. Angel (October)
5. Generoso Baladad "
6. Pedro Z. Madrid "
7. Jesus P. Mamisao, B.Agr., '30 "
8. Constancio Medrana, B.Agr., '27 "
9. Benigno Orig "
10. Melecio J. Ouano "
11. Sabas P. Tangco "
12. Wenceslao Villareal (October)
13. Juan F. Villaroel Jr. "

Bachelor of Agriculture

1. Felix N. Camba (October)
2. Jose H. Campo "
3. Gregorio S. Chan "
4. Getulio B. Viado "

Certificate in Agricultural Education

1. Francisco Barros, B.S.A. (June)
2. Sisenando Reantaso, B.Agr., B.S.A. (October)

Completing work in March, 1933

Bachelor of Science in Agriculture

1. Luis A. Aldea
2. Fidel H. Alonte, B.Agr., '30
3. Octavio Alzona
4. Cecilio B. Antonio
5. Perico Y. Arcedo
6. Alfonso T. Asuncion
7. Genaro M. Baquiran
8. Angel T. Battung
9. Pacifico R. Bautista
10. Angel Belandres
11. Apolinario D. Benitez
12. Jose P. Biboso
13. Filomeno L. Butac (Baker Scholar)
14. Elena M. Caguicla (Miss) B.Agr., '32
15. Marcelino G. Canlas
16. Eliseo C. Carandang

17. Magdaleno M. Cero, B.Agr., '32
18. Dominador D. Clemente
19. Felipe E. Crisostomo
20. Numeriano L. Cuevas, B.Agr., '32
21. Rafael T. David
22. Alberto C. Elefaño
23. Alfredo A. Francisco
24. Marceliano A. Ganay
25. Nicasio M. Garcia
26. Venancio R. Garcia
27. Justino Guiyab
28. Manuel S. de Guzman
29. Crispiniano C. Hernandez
30. Evaristo A. Hurtado
31. Juliano C. Jugo
32. Felecisimo S. Maceda
33. Ladislao G. Martir
34. Emilia O. Odjiar (Miss)
35. Ponciano F. Ortiz
36. Salvador P. Padilla
37. Adriel A. Palma, B.Agr., '32
38. Mariano C. Pamintuan
39. Leonor A. Pandinco (Miss)
40. Antonio A. Perez
41. Simon L. Perez, B.Agr., '31
42. Nazario A. Pidlaoan, B.Agr., '29
43. Jose N. Quintos
44. Ramon R. Reyes
45. Briccio O. Reynoso
46. Vicente S. Rongo
47. Juan M. Samson
48. Basunie Saropie
49. Jesus E. Segovia
50. Hilario Sicam
51. Elias V. Sombito
52. Cesar B. Tantoco
53. Conrado B. Uichanco
54. Lorenzo J. Valdez
55. David M. de Vera
56. Enrique R. Villanueva
57. Nicolas C. Villanueva
58. Lauro Ynalvez, B.Agr., '29

Bachelor of Agriculture

1. Proceso E. Alcala (Baker Scholar)
2. Jose T. Alhama
3. Nicanor S. Bartolome
4. Diosdado S. Bongato
5. Guillermo L. Canlas
6. Onofre M. Casupang
7. Eleuterio P. Enriquez
8. Olimpio R. Fontanilla
9. Benjamin Lazatin
10. Isabelo M. Monje
11. Domingo Y. Odejar
12. Mariano M. Ramos
13. Arturo de los Reyes
14. Bartolome J. Sison

Bachelor of Science in Sugar Technology

1. Newton L. Jison
2. Salvador B. Oliveros (*cum laude*)
3. Domingo S. Regner
4. Rafael B. Rotor, B.Agr., B.S.A.
5. Jose P. Sto. Domingo
6. Conrado S. Veloso

Certificate in Agricultural Education

1. Perico Y. Arcedo, B.S.A.
2. Dominador D. Clemente, B.S.A.
3. Domingo Tenebro, B.Agr., B.S.A.

Salvador B. Oliveros was awarded the "Joaquin Gonzalez Medal" and the "Faculty Medal of Merit."

The class '33 includes two women, Miss Emilia Odjiar and Miss Leonor Pandinco. This brings the number of women in the College of Agriculture Alumni Association up to six.

Getulio Viado was awarded the H. Atherton Lee prize of fifty pesos for the best theisis. By request of Mr. Lee theses on sugar were

not entered in the contest. The title of Mr. Viado's thesis was: "Anatomical studies on some common white grubs affecting Philippine field crops." Adviser was Dr. L. B. Uichanco.

Enrollment for Summer Session, 1933 as reported from Secretary's office:

Regular students	259
Cross-registrants from School of Forestry	3
Extension courses	48
Poultry	42
Plant Propagation	6

On the evening of March 11 in the College Auditorium the Varsity Sweaters and Letters, College Letters, trophies, medals and ribbons for the year 1932-1933 were awarded.

The program follows:

Part I

Song, A.—V.—F.	By the Audience
Procession	Varsity Letter Men College Letter Men
Opening Remarks	By the President, Los Baños Sub-Board of Athletic Management, Dr. R. B. Espino

Announcement of the results of the U. P. Manila vs. U. P. Los Baños Championship Games

Basket ball	Won by U. P. Los Baños
Volley ball	Won by U. P. Los Baños
Football	Won by U. P. Los Baños
Carnival relays	Won by U. P. Los Baños
Boxing	Won by U. P. Los Baños
Track and Field	Won by U. P. Los Baños
Tennis	Won by U. P. Manila
Baseball	Won by U. P. Manila

Part II

Song, "Push on U. P."	By the Audience
Talk, World Olympic Games at Los Angeles	By Prof. C. C. Bartolome, Head, Department of Physical Education.
Yells	By the Audience led by Cheer Leaders

Part III

Distribution of prizes and awards:

Song, "U. P. Band"	By the Audience

The Los Baños Sub-board of Athletic Management the past year revised the rules and regulations governing the award of College Letters, making the changes effective for 1932-22 awards.

The principal changes are: In team events, the one awarded a Letter must be a regular registered student in a college; must have played at least one full game in the U. P. Inter-section and his team must have won the championship.

In individual events, to be awarded a Letter one must win either first or second place in the U. P. Inter-section or Inter-unit games.

A winner of a Varsity Letter is entitled to a College Letter for the event.

A general requirement is that one must be a member of the college team and must attend practice regularly.

Stars

A new feature in U. P. Athletics in the awarding of stars. There are four stars awarded. A College Star, Varsity Star, P. A. A. F. Star and F. E. A. F. Star. These stars are awarded for exceptional achievement either in individual or team events.

ATHLETIC ACTIVITIES FOR COLLEGE YEAR

(C. A.) College of Agriculture; C. V. S.) College of Veterinary Science; (F. S.) Forest School; (R. H. S.) Rural High School.

U. P. Los Baños Intramural League

The Seniors, C. A. with a total of 74 points won the Intramural general championship.

Units	Basket ball	Volley ball	Football	Carnival relay	Track & field	Tennis	Total points
C. A. '33 (Seniors)	20	8	10	8	8	20	74
C. A. '34 (Juniors)	12	1 1/3	10	20	12	0	55 1/3
F. S.	0	12	4	0	20	12	48
C. A. '36 (Freshmen)	8	1 1/3	20	12	0	0	41 1/3
C. V. S.	0	20	0	0	4	8	32
C. A. '35 (Sophomore)	4	0	0	4	0	0	8
R. H. S.	0	1 1/3	0	0	0	4	5 1/3

U. P. Los Baños Intramural Carnival Relays

The following are the results of the U. P. Los Baños Intramural Carnival Relay:

C. A. (Juniors) .... 28 points
C. A. (Freshmen) .... 24 "
C. A. (Seniors) .... 22 "

U. P. Intramural track and field

The following are the results of U. P. Intramural track and field:

F. S.	47 5/6 points
C. A. (Juniors)	47 "
C. A. (Seniors)	32 "

U.P. Intramural Relay Carnival at U.P. Los Baños Athletic Field

Unit IV composed of the Associated Colleges at Los Baños won the U. P. inter-unit track relay championship at U. P. Los Baños Athletic Field. The events won by the Los Baños cinder path artists were 400-meter relay, long distance relay, sprint medley relay, and the 1,600-meter relay.

Results of the U. P. Intramural Carnival Relays were as follows:

First	Unit IV	40 points
Second	Unit II	24 points
Third	Unit III	12 points
Fourth	Unit I	6 points

U. P. Intramural Track and Field meet held at Manila

The following are the results of the U. P. Intramural Track and Field Meet held at Manila:

First	Unit IV	77 points
Second	Unit II	59 points
Third	Unit I	20 points
Fourth	Unit III	0 points

Winners of the U. P. Los Baños Intramural League

Volley ball	C. V. S.
Winner general championship	C. A. (Seniors)
Tennis	C. A. (Seniors)
Soccer football	C. A. (Freshmen)
Carnival relays	C. A. (Juniors)
Track and Field	F. S.
Basket ball	C. A. (Seniors)

Individual highest point winners

Pedro Y. Yatar	C. A. (Junior)
Amado B. Paggao	C. A. (Senior)

Varsity Sweater Men

Track and Field

Guillermo R. Manalo .... C. A. (Junior)

Basket ball

Alberto Elefaño .... C. A. (Senior)

Boxing

Adolfo Castillo .... C. A. (Senior)

Varsity Letter Men

Major Sports

Baseball:

1. Anselmo Guillen .... C. A. (Senior)
2. Emmanuel Elayda .... F. S.

Basket ball:

1. Briccio Reynoso .... C. A. (Senior)
2. Jesus Suarez .... C. A. (Freshman)
3. Romulo Payawal .... C. A. (Sophomore)

Track and Field:

1. Amado Paggao .... C. A. (Senior)
2. Pedro Yatar .... C. A. (Junior)
3. Pedro Lorenzo .... C. A. (Junior)
4. Teodoro Malasig .... C. A. (Freshman)
5. Guillermo Manalo .... C. A. (Junior)
6. Domingo Gapuz .... C. V. S.
7. Feliciano Gautane .... F. S.
8. Florentino Fontanilla .... F. S.

Soccer football:

1. Antonio Flores .... C. A. (Senior)
2. Jesus Suarez .... C. A. (Freshman)
3. Jose Utzurrum .... C. A. (Senior)
4. Chakr Charudat .... C. V. S.

Minor Sports

Volley ball:

1. Felicisimo Maceda .... C. A. (Senior)
2. Raul Ruiz de Arana .... C. A. (Senior)
3. Julito Marcos .... C. A. (Senior)
4. Jose Zaldivar .... C. A. (Freshman)

Boxing:

1. Adolfo Castillo .... C. A. (Senior)
2. Ceferino Maypa .... C. A. (Sophomore)
3. Rodolfo Pugeda .... C. A. (Sophomore)
4. Nemesio Gubatan .... F. S.
5. Ricardo Estrella .... F. S.

Tennis:

1. Jose Utzurrum .... C. A. (Senior)

Basket ball midget:

1. Avelino Bigornia .... C. A. (Junior)
2. Rafael Roces, Jr. .... C. A. (Junior)
3. Alberto Elefaño .... C. A. (Senior)

College Letter Men

Baseball:

1.	Anselmo Guillen	C. A.
2.	Emmanuel Elayda	F. S.

Basket ball:

1.	Briccio Reynoso	C. A.
2.	Jesus Suarez	"
3.	Romulo Payawal	"
4.	Alberto Elefaño	"
5.	Avelino Bigornia	"
6.	Rafael Roces, Jr.	"
7.	Julito Marcos	"
8.	Conrado Veloso	"
9.	Diosdado Boñgato	"
10.	Felino Rodriguez	"

Soccer football:

1.	Antonio Flores	C. A.
2.	Jesus Suarez	"
3.	Romulo Payawal	"
4.	Avelino Bigornia	"
5.	Jose Utzurrum	"
6.	Ceasar Mamon	"
7.	Phanom Smitananda	"
8.	Pablo Macariola	"
9.	Rafael Roces, Jr.	"
10.	Basunie Saropie	"
11.	Thuan Komkris	"
12.	Magdaleno Cero	"
13.	Chakr Charudat	C. V. S.
14.	Philandero Avanceña	R. H. S.

Volley ball :

1.	Felicisimo Maceda	C. A.
2.	Julito Marcos	"
3.	Raul de Arana	"
4.	Jose K. Santiago	"
5.	Felix Arriola	"
6.	Narciso Pepito	"
7.	Jose Zaldivar	"
8.	Santiago Banilan	"
9.	Guillermo Manalo	"
10.	Carlos Vargas	F. S.
11.	Regalado Benavidez	"
12.	Carpio Cenon	R. H. S.
13.	Felipe Crisistomo	C. A.

Boxing:

1.	Adolfo Castillo	C. A.
2.	Ceferino Maypa	"
3.	Rodolfo Pugeda	"
4.	Miguel Alba	"
5.	Nemesio Gubatan	F. S.
6.	Ricardo Estrella	"

Track and Field:

1.	Pedro Yatar	C. A.
2.	Amado Paggao	"
3.	Teodoro Malasig	"
4.	Pedro Lorenzo	"
5.	Guillermo Manalo	"
6.	Alfredo Gano	"
7.	Antonio Alberto	"
8.	Domingo Gapuz	C. V. S.
9.	Feliciano Gautane	F. S.
10.	Florentino Fontanilla	"
11.	Longinos Espinosa	"
12.	Felix Gaudencio	"
13.	Laureano Marquez	C. V. S.
14.	Crisostomo Marasigan	R. H. S.

Tennis:

1.	Jose Utzurrum	C. A.
2.	Dominador Clemente	"
3.	Osmundo Mondoñedo	"
4.	Octavio Alzona	"
5.	Mariano Pamintuan	"

Medals Awarded

P. A. A. F. (Philippine Amateur Athletic Federation)

1,500 meter run:		
First place	Pedro Yatar	C. A.
10,000 meter run:		
First place	Pedro Yatar	C. A.
1,600 meter relay:		
First place	Teodoro Malasig	C. A.
	Amado Paggao	"
	Pedro Lorenzo	"
400 meter hurdles:		
Second place	Amado Paggao	C. A.
400 meter run:		
Second place	Teodoro Malasig	C. A.
Running broad jump:		
Second place	Florentino Fontanilla	F. S.

Stars

P. A. A. F., Varsity and College Stars

Track and Field:

1. Pedro Lorenzo .... C. A.
2. Pedro Yatar .... C. A.
3. Amado Paggao .... C. A.
4. Teodoro Malasig .... C. A.

College Stars

1. Feliciano Gautane .... F. S.
2. Longinos Espinosa .... "
3. Florentino Fontanilla .... "
4. Domingo Gapuz .... C. F. S.

Boxing:

1. Adolfo Castillo .... C. A.

U. P. Inter-section Games

U. P. Manila vs. U. P. Los Baños

1. Basket ball—Winner, U. P. Los Baños—Captain, Briccio Reynoso
2. Boxing—Winner, U. P. Los Baños—Captain, Adolfo Castillo
3. Baseball—Winner, U. P. Manila—Captain, Ambrosio Padilla
4. Carnival Relays—Winner, U. P. Los Baños—Captain, Pedro Yatar
5. Track and Wield—Winner, U. P. Los Baños—Captain, Pedro Yatar
6. Tennis—Winner, U. P. Manila—Captain, Lope Yngayo
7. Volley ball—Winner, U. P. Los Baños—Captain F. Maceda
8. Football—Winner, U. P. Los Baños—Captain, Antonio Flores

IN MEMORIAM

ARSENIO BAYLA, B.Agr. '18.
Agricultural Economist, Bureau of Plant Industry

Manila, March 5, 1933

GLICERIO CAGUICLA. B. Agr. '31.
Junior Agriculturist Assistant,
British North Borneo Company
1931-1933.

Keningau, British North Borneo, January 31, 1933.

AN OBITUARY: EDGAR MADISON LEDYARD

Edgar Madison Ledyard, born May 10, 1875 in Plymouth, Michigan; died, March 6, 1933 in Salt Lake City. He entered the Philippine service as a teacher in 1904; served first in the Visayas, then in Bulacan, then in the Manila High School. When the College of Agriculture opened in 1909, he was Instructor in "agriculture,"—actually in entomology—and Mrs. Ledyard was Instructor in Modern Languages,—English and German. A year later, he became Assistant Professor of Entomology. After two more years, he was

EDGAR MADISON LEDYARD

given added title as Superintendent of Building and Sanitation. He was named Property Officer and Cashier in 1913. All of these titles merely confirmed his responsibility for duties previously assumed or imposed; their purpose was to give him earned increase in salary, while his promotion in academic rank was impossible. During the academic year 1911-12, Mr. and Mrs. Ledyard were on leave, studying in the University of Michigan. From his return in April, 1912, to my own return in July, Mr. Ledyard acted as dean of the college,—as he did for shorter periods on other occasions.

As acting dean, he signed the diplomas of the class of 1913. A year later, he became an alumnus of the college himself. He and Mrs. Ledyard resigned in 1914.

After a year of graduate study in the University of California, he was made agricultural director of the United States Smelting, Refining and Mining Company at Salt Lake City. His job then was to prove that smelter fumes were not ruining the neighboring agriculture, the company being defendant in countless suits for damage. Characteristically, he worked himself out of this job, by proving experimentally that the tenderest plants throve near the smelters, and winning every suit brought to trial. This made him a marked man. With promotions and increase of responsibility, he remained with the same company until his death. At the same time he was a consulting expert for various other great corporations.

As to his record in the college, I would quote from its records:

> I have just received your report for the past year as Assistant Professor of Entomology, Property Officer, Disbursing Officer and Cashier, and Superintendent of Buildings and Sanitation. I desire to express my cordial appreciation of this report, and to state that the recommendations made in it will, without exception, be put into effect as far as I am able to accomplish this. As your report carries a valedictory post-script, I find myself in the far from pleasant position of being obliged to recognize that this report covers the end of your service for this college. As I have repeatedly stated in annual reports and to others, your service here has been characterized by remarkably high practical value. I take great pride in the record which this college has made in the five years of its existence. The establishment of such an institution, and its management during its early years, are a problem essentially different from its administration in later years. I feel that we have succeeded in establishing this college, that its lines of endeavor have been largely mapped out, and that along the most important of these lines, the days of clearing and exploration are passed. In the most difficult pioneer work of the establishment of the college, you were my right hand.
>
> I note from your report that you think your work in sanitation is the most important you have done here. I do not believe I fail to appreciate this work when I disagree with you. This work has been valuable; how valuable no man knows, for no man can say what would have happened, or might still happen if the work had not been done. But the sanitation would never have been needed if the college had not been established or had not grown. I give a higher place to the service you rendered in the establishment of the college itself. In my own opinion, your most valued service to this college has been by your moral influence on the student body. As an example: I recall the time

when, by your personal influence, every unmarried pensionado sent to this institution had an account in the Postal Savings Bank, except one boy who had bought a carabao. By teaching habits of honesty and thrift and an attitude of fairness, and by making the whole student body feel the effect of this teaching, I consider that you performed a work of very much greater value than any system of sanitation we have planned should be considered to have.

The statement that he was "my right hand" has been made and quoted repeatedly. It was meant to be complimentary; the right hand does dependably whatever the brain wills. And right there the expression is most inadequate. He did do what was asked of him, and that was much. But, from the day the college opened, it was service on his own initiative which really distinguished him. His house was the first office of the college, and its first classroom. The sanitation of the college was his own project. His "campaign"—this use of the word had not yet been invented,—for student thrift, industry, and personal independence were on his own initiative. I thank nobody else in any similar measure for the character stamped on the student body of the college during its most plastic days.

For myself, I have lost such a friend as I do not expect to find again.

EDWIN BINGHAM COPELAND
Founder and First Dean, College of Agriculture

The following tribute is an excerpt from the special issue of *Ax-I-Dent-Ax*, the Employees' Magazine of the United States Smelting, Refining and Mining Company and Subsidiaries. The issue bears the title, "A Tribute to Edgar M. Ledyard".

EDGAR MADISON LEDYARD

The busy paths of life seem so often to turn prematurely and abruptly, by means of a hidden entrance, into the Valley of Shadows. Such was especially the case with the brilliant career of Edgar M. Ledyard, Agricultural Director for this Company since 1915, and, incidentally, Editor of its employees' magazine, the Ax-I-Dent-Ax, since 1929. In his untimely death this Company is deprived of the valued services and loyal support of a distinguished scientist whose peculiar place, carved out by himself, cannot be filled by another;

the community which he loved loses an aggressive and successful champion of many worthy causes; and numerous individuals, prominent and lowly, are cast within the gloom of sorrow.

A true Scotsman, he was instinctively frugal of his facilities and his time. Likewise he was instinctively generous in sharing and giving, with the tender sympathy of woman. Unostentatiously he materially aided many young men and women to earn some needed funds, to gain an education, or to attain a permanent position. One of his chief sources of satisfaction and interest was in seeing these people flourish under opportunities he had given them. But he was sensitive to any delinquency or breach of faith. To him idleness, indolence and unworthiness were major sins; while sham, fraud and hypocrisy received from him a quick, frank and untempered rebuke. He demanded and inspired the best in everyone within the horizon of his interest.

He loved life enthusiastically for the opportunities it gave him for individual achievement, following his own wholesome inclinations. He enjoyed a lively contest, if fairly waged; and had a strong leaning toward the unfortunates of the earth, the "under dogs," the forgotten men and women, bereft of a needed patron. Having a fearless independence of thought, he would never compromise a conviction or a principle to gain an ally or effect a cooperation, but would rather go his way alone, maintaining lofty goals before his vision. Thus his intimate friends were selected carefully and sparingly; and he demonstrated abundantly that his recipe for having staunch friends was to be one.

Endowed with rare intellect, uncanny discernment, a remarkable memory, a commanding personality, the initiative to make his own opportunities, and a tremendous amount of energy for carrying them out, he crowded into his brief span of years the achievements of an unusually generous lifetime, leaving a great many worthwhile projects unfinished. Always confident and buoyant, he willingly carried an immense load; but suddenly an overtaxed heart, impaired beyond his knowledge, proved inadequate to carry him through a dual siege of gallstones and pneumonia. His work was to him a religious expression, of honesty, truthfulness, thoroughness, fairness, charitableness, and benevolence. Thus his deeds become his own lasting memorial, erected in the hearts of those touched by his influence. A full life, richly lived, is the well earned benediction on his head.

FLORAL MORPHOLOGY OF MUSA ERRANS (BLANCO) TEODORO VAR. BOTOAN TEODORO [1]

JOSÉ B. JULIANO AND PROCESO E. ALCALA[2]
Of the Department of Plant Physiology

WITH FIVE PLATES AND ONE TEXT FIGURE

Taxonomic (Teodoro, 1915, and Quisumbing, 1919) and agronomic (Elayda and Morada, 1931) studies on Philippine bananas are rather extensive and thorough, but very little morphological work has been done locally. In his study on the development of the seeds in Scitimineae, Humphrey (1896) found five fertile stamens in *Musa rosea* and sometimes a small staminodium in the place of the sixth stamen of which the androecium is composed. Filamentous and septate structures arise from the placentae and bases of the funiculi and the testa of the seed consists of an outer deeply palisaded layer and an inner layer of large cubical cells.

Tischler (1913) reported a normal development of the embryo sac in "Rajah Siam", "Rajah Sereh" and "Njonha Bali", and that these same embryo sacs were situated below the periclinally elongated nucellar cells. He further found that the outer integument was absolutely degenerated in the mature seeds.

D'Angremond (1912) made mention of the fact that *Musa paradisiaca* Linn. subspecies *sapientum* is parthenocarpic and upon crossing it with Appelbacove, few seeds were developed. The development of the embryo sac in Appelbacove is generally normal, although some abnormalities, such as the formation of five or more megaspore daughter cells instead of the usual four, were found by him. The nucleus of the megaspore mother cell may divide without any wall formation, and in a great majority of cases the contents of the older megasporanges are wanting; the cause or causes of which were not given by the author.

In his more extensive report, D'Angremond (1914) described the inflorescence of Gros-Michel (*Musa paradisiaca* Linn. subspecies *sapientum*) and *Musa ornata* var. *chittagong*. He stated that the

[1] Experiment Station contribution No. 890. Received for publication, April 11, 1933.

[2] The greater part of the data in this paper was presented by the junior author, a Baker Memorial Scholar, in his thesis for graduation, March, 1933, with the degree of Bachelor of Agriculture from the College of Agriculture, No. 348.

first three bracts of the inflorescence subtended no flowers, the sixth to twelfth, female flowers, and the rest, male flowers. He traced the development of the microspores and found each of the mature microspores from *Musa ornata* var. *chittagong* and Gros-Michel possessed a generative and a vegetative nucleus. He performed some germination studies of the microspores, and recommended a medium consisting of 8 per cent sugar and 10 per cent gelatine. The development of the embryo sacs in some of these varieties of banana followed the conventional. But in some of them the mature embryo sacs contained only antipodals, or only egg-apparatus, and in extreme cases they were empty. The last condition was true with the parthenocarpic varieties he worked on. He reported cases where two embryo sac mother cells developed in megasporange of Appelbacove and a "tetrad" of five cells was actually formed. In his attempt to produce seeds he performed pollination experiments with the following results: with Gros-Michel (♀) and Appelbacove (♂) only four seeds were formed; with Appelbacove (♀) and Gros-Michel (♂) thirty-eight seeds; with Gros-Michel (♀) and *Musa ornata* var. *chittagong* (♂), abundant seeds. He further stated that the edible bananas were parthenocarpic and that artificial pollination had no influence on the shape and size of the fruits.

In an attempt to produce a more resistant cross between Gros-Michel, an immune and sterile variety, and some other seeded varieties of bananas, White (1928) first made both morphological and cytological studies on several varieties now grown in the Plattfield Plantation of the United Fruit Company in Jamaica. He studied the development of the inflorescence and floral organs of the flowers. Like D'Angremond (1912, 1914), White (1928) found the development of the embryo sac in Gros-Michel to be normal with some freaky formation of the megaspores. In Rodoc Clamp [3], a regularly seeded variety of *Musa basjoo* Sieb & Zucc. (?) var., the development of the embryo sac was believed by White (1928) to be normal, although no detailed studies of the earlier stages were made. He also traced the development of the microgametophyte and found that the division of the microspore mother cells was successive with the formation of linear and tetrahedral tetrads.

Recently, Skutch (1927, 1931) made a very extensive and exclusive study on the anatomy of the axis and leaf of bananas. His reports include detailed descriptions of parts from the base of the stolon to the tip of the "protecting leaf".

[3] According to White (1928) this variety originated from the Philippines.

Our knowledge on the floral morphology of our Philippine bananas with special reference to *Musa errans* (Blanco) Teodoro var. *botoan* Teodoro is fragmentary, hence this study. In this study an attempt was made to prove whether or not pollination is necessary in the normal development of the fruit of this variety of banana. In a work of this nature one is always tempted to take up the development of the inflorescence as well as the fruit and seed, because these are either the origin or the end products of the flowers. While the findings herein reported may not wholly answer the numerous questions relative to the improvement of our seedy bananas, they may serve as bases for more extensive studies if these become necessary in the future.

MATERIAL AND METHODS

The material used in this study was obtained from a seeded variety of banana, *Musa errans* (Blanco) Teodoro var. *botoan* Teodoro, which was growing along Molawin Creek below the Experiment Station Bridge and from banana plants in the barrios of Anos and San Antonio, Los Baños, Laguna, during the period from November, 1931 to October, 1932, inclusive. Inflorescences of different sizes as well as fruits and seeds at different stages of growth and development were gathered from time to time from plants which produce fertile seeds and from those which produce sterile seeds.

Laboratory study

The material was fixed either in the field or in the laboratory. The fixatives tried in this study were chromo-acetic solution, Bouin's fluid, Carnoy's fluid, and formo-acetic-alcohol (70 per cent) prepared according to the formulae given by Chamberlain (1924). Of these fixatives, chromo-acetic solution was found to be best for the megasporanges (ovules) and seeds, and formo-acetic-alcohol (70 per cent) for the anthers, inflorescences and young fruits. The material was embedded in paraffin in the usual manner and cut five to ten micra thick. Difficulty in sticking the paraffin ribbons from ovaries and fruits of rather advanced stage of growth was experienced by the writers as well as by D'Angremond (1912, 1914). White (1928) did not encounter such difficulty owing, perhaps, to the difference in fixatives used by him. The ordinary Mayer's egg albumen and Land's gum arabic fixative as given by Chamberlain (1924) did not help much in overcoming the difficulty. However, by eliminating the glycerine constituent from Mayer's egg albumen fixative, the ribbons were found to hold fairly well on the micro slides. The floating of the sections was due to the expansion of

mucilaginous secretion of the filamentous outgrowths from the placentae and bases of the funiculi of the megasporanges (pl. 2, fig. 17) and young seeds. This secretion expands in the presence of water and mechanically detaches the sections from the micro slides even though the fixative is present.

Several stains were tried, among which were triple stain, safranin-light green, Heidenhain's iron-haematoxylin with orange gold dissolved in clove oil as counter stain, and safranin-Delafield's haematoxylin combination. The last two combinations proved very satisfactory.

Field study

In order to prove whether pollination is necessary in the normal development of the fruit in this variety of banana, several inflorescences from both hard- and soft-seeded forms were bagged with cheese cloth [4]. Bagging was done before any fertile bract had opened and care was exercised to prevent the entrance of microspores. The bags were removed three days after the last bract subtending female flowers had opened. Observations were made on the performance of these bagged inflorescences.

With the object of confirming the results obtained from the treatment given above another operation was carried out. The description follows: A few hours before anthesis the writers opened with their fingers the bract subtending the female flowers on the inflorescence and the flowers in each fascicle were divided into three groups. In the first group the stigmas were clipped off with a pair of scissors: the second group was pollinated artificially with microspores from mature stamens of *Musa sapientum* Linn. var. *compressa* (Blanco) Teodoro and *Musa errans* (Blanco) Teodoro var. *botoan* Teodoro, and then bagged; the third group served as the control, so was not treated at all. This same procedure was followed for all the female fascicles on the inflorescence of both the hard-seeded and soft-seeded forms. A few flowers from each of the lots were gathered at intervals of 12 hours (for three days) and every two days thereafter, until the seeds were rather hard to the touch. These flowers and young fruits were fixed as usual and were cut for microscopical examination as described above.

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[4] Bagging and clipping experiments were also made on other varieties of bananas; namely, (1) Latundan, *Musa sapientum* Linn. var. *cinerea* (Blanco) Teodoro, (2) Saba, *Musa sapientum* Linn. var. *compressa* (Blanco) Teodoro, (3) Lakatan, *Musa sapientum* Linn. var. *lacatan* (Blanco) Teodoro, and (4) Gloria, *Musa sapientum* Linn. var. *ternatensis* (Blanco) Teodoro. It was found that these varieties are parthenocarpic and no alteration on the normal development of the fruit was observed from any of them.

OBSERVATIONS

The inflorescence and the flowers

Description. The inflorescence of *Musa errans* (Blanco) Teodoro var. *botoan* Teodoro is a large, ovate-oblong, indefinite, terminal and pendant spike. On its axis are arranged in 3-ranked spiral succession numerous bracts in the axils of which are subtended 2-rowed fascicles of flowers. The first three basal sterile bracts are oblong-lanceolate, light green to reddish orange inside and green outside. The fertile bracts are pubescent, yellowish red above, light green inside with yellow patches at the base and are partly persistent (pl. 5, fig. 56 and 58). In the axis of the basal fertile bracts are subtended the female or pistillate flowers. Usually, above these female floral clusters are one to two fascicles of neuter or "pseudo-hermaphrodite" flowers. Succeeding these neuter flowers towards the apex of the inflorescence are numerous fascicles of staminate or male flowers.

The individual female flower (pl. 1, fig. 10-11) is from 8 to 10 centimeters long, possessing a pale yellow, 5-toothed perigonium, the lobes of which are golden yellow in color. It possesses six staminodia which are short, stubby, club-shaped structures above the ovary. One of these staminodia is reduced to a slender thread-like structure, gradually tapering towards the tip. Occasionally a few of the female flowers possess one to five fertile stamens (pl. 1, fig. 11) which form fertile microspores. Above the ovary and just surrounding the whorl of six staminodia is a poorly developed nectary. This may secrete a thick mucous-like substance which collects in the scale. The scale is an oblong, boat-shaped, white structure with a short acute apex. The pistil consists of (1) a large columnar style surmounted at its apex by a globose stigma and (2) an inferior ovary which is tricarpous, pale yellow and angular. Five carpels may take part in the formation of the pistil, and this may be attributed to twining of the adjacent pistils so common in our parthenocarpic bananas. This is of rare occurrence in this variety of banana. The placentae are axillary, and arise from the fusion of the margins of the carpels. On each placenta two rows of anatropous megasporanges are formed.

The neuter flower (pl. 1, fig. 9) is very much smaller than the female flower and nearly equals the male flower. On the upper portion of its ovary is a well developed nectary. Some flowers in the neuter fascicle may contain one to five fertile stamens and these can only be differentiated from the true staminate flowers by their

size and persistence on the mature fruit cluster. The neuter flowers whether they possess few fertile or all sterile stamens remain as degenerated small fruits which are a few centimeters long, and scarcely one centimeter thick (pl. 5, fig. 62). These degenerated fruit-like structures persist until the rest of the bunch ripen. The ovary is slightly longer but more slender than that of the male, and possesses no true loculi. It is provided with an irregularly branched opening lined with glandular epithelium (pl. 3, fig. 28). The stamens are reduced as in the female flowers.

The rest of the upper distal portion of the inflorescence is occupied by the male flowers. Each of the flowers (pl. 1, fig. 12) possesses a single perigonium and scale similar to those found in the female and neuter flowers. The pistil of the male flower is a little bit shorter and less plump than that of the neuter. Its ovary is much more slender, and its stigma is much smaller than those of the two kinds of flowers described above. The nectary of this flower is very well developed. The stamens are large and well developed with the white filaments convex on their abaxial sides and concave on the opposite sides. The anthers possess four sporanges which dehisce along the longitudinal sutures.

Ontogeny or development. The ontogeny of the pendant, spicate inflorescence of this variety of banana and apparently of two distinct forms, one of which produces hard germinable seeds, and the other, soft sterile seeds, show a very marked similarity to that reported by White (1928) in Jamaica. It starts as a dome-shaped apical meristem which can easily be distinguished from the vegetative growing point by its relatively broad size, becoming concave at first and later assuming a blunt conical apex. It differentiates just at the time the stem begins to elongate, and at times the stem has actually elongated for some time before the first fascicle is formed. The growing point cuts off lateral ridges, one at a time, at its convex apex extending to almost half its circumference and these give rise to the bracts. Usually, the three basal bracts are sterile and subtend no flowers. When the height of the young bract is twice its width in longitudinal section, the fascicular primordium (pl. 1, fig. 1) appears as a mammillate hump at the axis. This fascicular primordium then elongates obliquely, and after it has grown to an appreciable length it bifurcates, giving rise to two rows of floral primordia (pl. 1, fig. 3). These floral primordia develop into pistillate, neuter and staminate flowers, depending on their position on the axis of the inflorescence. It seems that this method of develop-

ment of the inflorescence is followed with regularity in nearly all of the species of *Musa,* especially so in those reported by White (1928) and in the Philippine seeded variety of banana.

The development of the floral organs of the three kinds of flowers is *acropetal* and the description of that of the male will, therefore, suffice. The floral primordium is flattened at its apex and very soon the three lobes of the outer perianth (pl. 1, fig. 2) arise simultaneously at the periphery of that flattened primordium as three hemispherical masses in a single whorl. Before they have elongated to any appreciable extent the inner whorl of three perianth lobes (pl. 1, fig. 3) are cut off within the outer perianth segments and these inner lobes alternate with the outer. These perianth lobes, outer and inner whorls, then elongate together for some time. This active growth of the perianth lobes leaves the growing point as a depression within. The next organ to be formed is the stamens which arise as six small tubular structures within the inner whorl of the perianth lobes (pl. 1, fig. 4). The last floral organ to appear is the pistil (pl. 1, fig. 5). The floral organs, therefore, arise in the following sequence: outer perianth lobes, inner perianth lobes, stamens and pistil. White (1928) who also traced the sequence of development of the floral organs of those species of *Musa* in Jamaica, reports that the stamens are in two whorls and that the outer whorl of three stamens arise at the same time with the inner whorl of perianth lobes. An examination of the transverse section of the young male flower (pl. 1, fig. 7) surely reveals that three of the stamens are in line with the whorl of inner perianth lobes. However, examination of the longitudinal sections of the flowers shows a different story (pl. 1, fig. 6). These stamens arise from different points on the floral primordium and as they elongate they push themselves outward and so align themselves with the inner whorl of perianth lobes. Macroscopically, White (1928) may have been misled in his interpretation.

Long before anthesis the three lobes of the outer perianth fuse together and with two of the abaxial lobes (pl. 1, fig. 7) of the inner perianth, form the perigonium (pl. 1, fig. 8). The axial lobe of the inner perianth, alone, (pl. 1, fig. 7) contributes to the development of the scale (pl. 1, fig. 8). Of the six stamens generally differentiating in the young flower only the axial one aborts (pl. 1, fig. 8) in the male flower; in the female and neuter flowers all abort. Sometimes a few of the staminodia in the female (pl. 1, fig. 11) and neuter flowers may enlarge and actually produce fertile microspores.

Megasporange and megagametophyte

The megasporange is already differentiated at the time the inflorescence is about midway in the pseudostem or when the ovary is about one centimeter long and one fourth centimeter in diameter. It appears as a conical protuberance from the placental wall and grows directly at a right angle to the ovary wall. The megasporange then is at first atropous, and by differential growth it becomes anatropous with its micropyle pointing in all directions. It possesses two distinct integuments, a thick outer integument and a thin inner (pl. 2, fig. 17), which arise basipetally. The development of the megagametophyte in both forms of this variety of banana is identical.

The megagametophyte of the Philippine seeded variety of banana is of the normal type and follows the conventional. The early history of its development follows that of the parthenocarpic Gros-Michel (D'Angremond, 1914, and White, 1928), and the mature megagametophyte is similar to that of the seeded Rodoc Clamp (White, 1928). The inner integument has already been formed when the archesporium arises from a subepidermal cell at the summit of the nucellus (pl. 2, fig. 13). This archesporial cell is easily distinguished from the surrounding cells by its relatively large size and great affinity for stains. It is polygonal in shape with its elongated axis parallel to the nucellus of the megasporange. This cell divides periclinally into an outer primary parietal cell and an inner megaspore mother cell (pl. 2, fig. 14) so often reported among monocotyledonous plants (Coulter and Chamberlain, 1903). This division of the archesporium takes place prior to the differentiation of the outer integument, and just at the time the megasporange is half anatropous. The primary parietal cell does not become very active so the megaspore mother cell is usually separated from the epidermis of the nucellus by a single layer of parietal tissue (pl. 2, fig. 15). One or two periclinal divisions may take place among some of the parietal cells (pl. 2, fig. 16), so that two or three layers of parietal tissue may be found between the megaspore mother cell and nucellar epidermis. This thin or rather thick parietal tissue is eventually destroyed by the subsequent development of the megaspore mother cell. Among the Scitimineae the presence of parietal tissue is generally the rule (Humphrey, 1896, Wiegand, 1900), although Guignard (1882) reports that in *Canna indica* parietal tissue may sometimes not be developed at all.

The megaspore mother cell with its enlarged apex directed towards the micropyle (pl. 2, fig. 15 and 16) then elongates very rapidly until it finally reaches the epidermis of the nucellus. Its nucleus also enlarges and its cytoplasm increases in amount and becomes thick. When the nucleus is in synapsis (pl. 2, fig. 16), the nucellar epidermal cells lining the micropyle radially elongate until they form a thick micropylar pad (pl. 3, fig. 42). By two successive divisions of the megaspore mother cell a row of four megaspore daughter cells (tetrad) are developed (pl. 2, fig. 18, 19 and 22). Sometimes the outer of the two megaspore cells may exhibit early degeneration (pl. 2, fig. 20) and only the inner divides. Three (pl. 2, fig. 21) instead of the usual normal four megaspores are, therefore, formed, as is true also with *Dieffenbachia* (Campbell, 1900). The formation of three or four megaspore cells are found to be of general occurrence among many monocotyledonous plants. Three megaspores are usually formed in *Anthericum ramosum* (Strasburger, 1879), and *Tricyrtis* and *Yucca* (Guignard, 1882). However, Ikeda (1902) reports four megaspores in *Trycirtis hirta* and Vesque (1879), three in *Hemerocallis, Allium,* and *Convallaria.* Three or four megaspores are developed in *Zostera* (Rosenberg, 1901) and *Potamogeton* (Wiegand, 1899, Holferty, 1901). Among the Scitimineae, Humphrey (1896) observed the formation of three or four megaspore cells as the rule, with the exception of *Costus* where the megaspore mother cell does not divide at all. In both cases the innermost megaspore mother cell becomes functional (pl. 2, fig. 22), and gives rise to the normal seven-celled megagametophyte. The functional megaspore cell then enlarges and elongates, and the nucleus usually remains at its center. Soon this nucleus moves to the micropylar region of the uninucleate megagametophyte (pl. 2, fig. 23) where it finally divides, giving rise to two daughter nuclei (pl. 2, fig. 24). These two daughter nuclei migrate to the opposite poles (pl. 2, fig. 25) where they divide forming the quadri-nucleate megagametophyte (pl. 2, fig. 26) and by one more division these nuclei form the seven-celled megagametophyte which is found in many angiosperms.

The mature megagametophyte is similar to that of Rodoc Clamp (White, 1928) in shape and contents. It shows a distinct egg-apparatus (two synergids and a megagamete), two polar nuclei and three antipodal cells (pl. 2, fig. 27). Among the Musaceae, normal development of the female gametophyte has been reported in *Musa coccinea* (Tischler, 1913), *M. paradisiaca* (D'Angremond, 1912), *M. ornata* var. *chittagong* (D'Angremond, 1914), *Strelitzia reginae*

(Brown and Sharp, 1911), and *Heliconia psittacorum* (Humphrey, 1896). The synergids are irregular in shape, and each possesses a thick vacuolated cytoplasm, and a single nucleus which may remain either at or farthest from the center of the cell, and usually farthest from the micropyle. These synergids may persist for some time after fertilization (pl. 3, fig. 40) and then degenerate. The megagamete possesses a dense cytoplasm and a rather distinct, large nucleus. It is always larger than either of the two synergids.

The antipodal cells lie in a large chalazal socket of the embryo sac, each possessing fairly distinguishable walls, thin cytoplasm, and small rhomboidal nucleus. Like the synergids, the antipodal cells may also persist even after fertilization for some time in the embryo sac as degenerated cells with deeply stained nuclei and hardly distinguishable walls (pl. 3, fig. 40). The antipodals usually disappear later than the synergids. The presence of three small, ephemeral antipodal cells is a general character of the Scitimineae as of the Musaceae (Tischler, 1913; D'Angremond, 1914; and White, 1928), the Cannaceae (Guignard, 1882; Wiegand, 1900) and the Marantaceae (Schachner, 1924). However, Lötscher (1905) observed only one large antipodal cell in *Elletaria* sp. and *Costus* sp., both belonging to the family Zingiberaceae. Schnarf (1929) believes that this deviation in the group might have been due merely to misinterpretation.

The polar nuclei usually lie near the opening of the basal (pl. 2, fig. 27) socket or may actually be near the antipodals. They remain intact for a long time, and generally fuse during fertilization.

Microsporange and microspores

Of the three kinds of flowers formed in this variety of banana, only the male flowers, seldom the female (pl. 1, fig. 11) and the neuter, form fertile stamens. Out of the six stamens formed in a single staminate or male flower, only five reach maturity, and produce fertile microspores.

The young stamen is early differentiated into a rather stout short filament and a long slender anther (pl. 1, fig. 12). The anther is at first a mass of similar cells surrounded by an epidermis which is more or less circular in outline. Later, it becomes four-lobed in transverse section and enlarges (pl. 3, fig. 29) before the archesporium is actually developed. The primary archesporial tissue is differentiated at the central portion of each lobe (pl. 3, fig. 30) of the anther at the time the male flowers are from two to three millimeters in length. The archesporium as well as the tapetum arise

simply by single regional differentiation among the central cells of the lobes of the anther similar to that reported for Rodoc Clamp by White (1928). The cells of the archesporium then enlarge, and their cytoplasm becomes more dense than that of the surrounding cells. These archesporial cells which possess large nuclei, function directly as the sporogenous tissue or microspore mother cells as is true in *Malva, Datura, Mentha, Chrysanthemum* (Coulter and Chamberlain, 1903) and several species of Asclepiadaceae (Strasburger, 1901, and Frye, 1901). The cells directly surrounding the microspore mother cells function as the tapetum.

The microspore mother cells are at first polyhedral (pl. 3, fig. 30-31) with dense cytoplasm and well defined nuclear membranes. Before the microspore mother cells pass into synapsis they, together with the tapetal cells, separate from the parietal tissue *en masse* (pl. 3, fig. 31), after which time their vacuoles may disappear completely (pl. 3, fig. 32). They then round off and proceed to divide. The division of the microspore mother cells is successive (pl. 3, fig. 33 and 35), and the tetrads are either arranged in a linear (pl. 3, fig. 34 and 36) or tetrahedral fashion (pl. 3, fig. 35). Successive divisions of microspore mother cells have been reported in *Musa sapientum* (Tischler, 1910, D'Angremond, 1914), *Heliconia bihai* (Schnarf, 1929), *Musa basjoo* (White, 1928), *Curcuma colorata, Costus cylindricus, Alpinia gigantea, Canna indica, Maranta sanguinea and Thalis dealbata* (Schnarf, 1929), and in *Nipa fruticans* (Radermachera, 1925). The microspores after being formed separate from one another, round off, and acquire their own coats. Soon after rounding, the microspore forms a thick mucous membrane and a large central vacuole appears (pl. 3, fig. 37) in it. The young microspore then possesses a round to ovate nucleus at its periphery. After it has reached its full size, the vacuole usually disappears and its nucleus divides. One of the daughter nuclei enlarges and stays at the center of the microspore, loses its chromatic character, and becomes the vegetative nucleus (pl. 3, fig. 38). The other nucleus which is lenticular, functions as the generative nucleus, and may lie next to the wall of the microspore or at the center of the dense cytoplasm. Examination of microspores before dehiscence will show the presence of two to seven tube nuclei (pl. 3, fig. 39) of different sizes lying with a single generative nucleus. These supernumerary tube nuclei seem to be empty, and each possesses a single peripheral black nucleolus. The presence of these extra tube nuclei do not have any morphological significance at all, but their presence in many of the microspores is rather inter-

esting to note. This may be attributed to the fragmentation of the tube nucleus under certain conditions of nutrition (Coulter and Chamberlain, 1903), and this same phenomenon has been reported in *Lilium trigonum* (Chamberlain, 1897) in which four and in one case eight tube nuclei were found. Smith (1896) discovered that half of the microspores he examined from *Eichornia crassipes* exhibited two pollen tube nuclei, while Fullmer (1898) counted as many as two to eight supernumerary tube nuclei in the microspores of *Hemerocallis fulva.* In *Asclepias,* Frye (1901) also observed fragmentation of the tube nucleus.

The formation of three microspores instead of the normal four from a single microspore mother cell was often observed by the writers especially from the linear tetrads (pl. 3, fig. 34) from the two forms of Philippine seeded bananas. This same thing was reported in Appelbacove by D'Angremond (1914). This degeneration of some of the pollen grains is believed by White (1928) to be due to the abnormal behavior of the tapetum and the archesporium, which is shown by the early, late or no cytokenesis in the pollen mother cells, or in extreme cases by the unequal distribution of the nuclear material during the heterotypic and homotypic divisions of the microspore mother cells.

The tapetal cells are at first uninucleate, but by the time the microspore mother cells are rounding, they become binucleate by simple mitotic divisions of their nuclei. Similar behavior of the tapetal cells was observed by White (1928) in *Musa basjoo.* Binucleate tapetal cells are found in *Typha latifolia* (Schaffner, 1897), *Eichornia crassipes* (Smith, 1898) and *Lactuca sativa* (Jones, 1927). In the last species the tapetal cells become binucleate at about the beginning of synezesis, or a little earlier, but later they become quadrinucleate. These binucleate tapetal cells in *Musa errans* (Blanco) Teodoro var. *botoan* Teodoro together with the rest of the parietal tissue, except the two hypodermal layers of cells below the epidermis of the anther, are absorbed by the developing microspores. In other words at maturity of the anther, only the epidermis, endothecium and a single layer of cells below it remain in each lobe. The epidermis of the anther remains parenchymatous, while the endothecium (pl. 3, fig. 41) becomes sclerenchymatous and greatly aids in the dehiscence of the microspores. The characteristic rod-like thickenings found in the endothecium of many anthers of angiosperms are not developed in this tissue of this variety of banana.

The fruit

Description. The oblong, curved, and angular fruit of this variety of banana which produces hard germinable seeds (pl. 5, fig. 63) is pale green, turning yellowish orange when ripe; the sterile soft-seeded form is a deep green to yellowish green at maturity. In both forms the perianth segments, the styles and staminodia, or in some cases even the fertile stamens, are more or less persistent on the fruit (pl. 5, fig. 56 and 62). The fleshy portion in which are embedded numerous black (hard-seeded form) or whitish (soft-seeded form) seeds is whitish in color. The fruit at maturity measures from ten to twenty centimeters in length with an average diameter of four centimeters.

The normal development of the fruit in both forms necessitates pollination. This is shown by the fact that if the inflorescence were bagged (pl. 5, fig. 57) or the stigmas of the female flowers were clipped off (pl. 5, fig. 59, 61 and 62), the fruits remained small and aborted, as compared with the normal fruits left undisturbed (pl. 5, fig. 60) or artificially pollinated (pl. 5, fig. 61). However, in some of our non-seeded varieties of bananas such as *Musa sapientum* Linn. var. *cinerea* (Blanco) Teodoro, *M. sapientum* Linn. var. *compressa* (Blanco) Teodoro, *M. sapientum* Linn. var. *lacatan* (Blanco) Teodoro, and *M. sapientum* Linn. var. *ternatensis* (Blanco) Teodoro, pollination is not necessary in the proper development of their fruits as shown by repeated bagging experiments conducted by the writers.

Pericarp. A question that is of much interest is the morphological nature of the edible portion of the fruit of this seedy banana. Examination of numerous preparations reveal that two distinct groups of tissues participate actively in the formation of the fleshy edible portion in this fruit. The first consists of the placentae, the walls of the loculi, the axis, and portions of the funiculi of the seeds with the multicellular filamentous outgrowths coming from their bases. The second comes from the pericarp of the fruit.

At the time the ovary is less than two millimeters in length its wall is composed of a homogenous mass of parenchymatous, isodiametric small cells, delimited on both sides by distinct pentagonal to rectangular epidermal cells. Later, the cells toward the middle portion of the ovary wall increase in diameter and from thence the wall consists of (1) an outer portion (exocarp) of small cells wherein are found numerous vascular bundles and (2) an inner portion (endocarp) of large cells which become smaller inward (pl. 4, fig. 54).

This differentiation of the ovary wall was observed when the flower was three millimeters in length and the ovary was two millimeters long.

Long before the differentiation of the archesporium in the megasporanges takes place, and while the inflorescence is at the middle of the pseudostem, distinct formation of the intercellular spaces was observed in the endocarp (pl. 4, fig. 55). At anthesis these air spaces have enlarged to such an extent that aerenchyma is actually formed (pl. 4, fig. 53) in it. The subsequent enlargement of the ovary compressed these large air spaces in the endocarp, and this tissue looked like that usually developed in floating organs of many hydrophytes. By the time the fruit is about ripe (pl. 4, fig. 62) the exocarp possesses few and rather smaller air spaces than those in the endocarp (pl. 4, fig. 46). Because of the more compact nature of the cells of the exocarp, the air spaces in it are never compressed, and they remain undeformed until maturity of the fruit. Also the presence of vascular bundles in the exocarp renders it more resistant to the pressure exerted by the enlarging tissues within.

The endocarp further undergoes complete differentiation when heavy deposition of starch grains takes place in its cells before the ripening of the fruit (pl. 4, fig. 46). The dissepiments which actually separate adjacent compressed, large air spaces are composed of one to two rows of cells. The vascular bundles are absent, and the endocarp becomes soft and juicy. This tissue easily separates from the exocarp and adheres tenaciously to the soft tissues enclosed by it. Of the pericarp, therefore, the endocarp contributes to the edible portion of the fruit and the skin or peel is but a part (outer) of the mature ovary wall. It might not be incorrect to conclude that the order of the development of the fleshy portion in this fruit would apply equally well to all parthenocarpic fruits of *Musa sapientum* Linn., except that in them even the aborted seeds contribute to some extent in the sum total of their fleshy edible portion.

The seed

Development. The mature seeds from both forms of this variety of banana are round to ovate or cordate in shape, with two of their sides flattened or compressed. A great majority of the seeds from the soft-seeded form are whitish, soft, and are much deformed and exude a milky substance when pressed between the fingers. A few of them may become plump and hard, but at full

maturity of the fruit such seeds become soft. Both kinds of seeds when about to mature vary in diameter from 4.1 to 4.9 millimeters on their flat sides, and 5.1 to 5.9 millimeters on their greatest diameters.

The trend of development of the seed herein reported agrees with that reported by White (1928) for Rodoc Clamp. Before the megasporanges are fertilized, the embryo sac occupies the extreme micropylar portion of the nucellus (pl. 3, fig. 42 and 43) on the top of which is the characteristic micropylar pad so well developed in the species of *Musa*. Soon the tissues of the nucellus lying adjacent to the integument and extending from the walls of the embryo sac outward and downward to the chalaza begin to break down to form an inverted funnel-shaped cavity with the main mass of the nucellus in the center intact. This "autolytic" process gradually extends downward and then inward until the central mass of nucellar tissue is completely cut off from the chalazal end and is left suspended in the cavity of the embryo sac alone (pl. 4, fig. 44). This nucellar mass may remain for some time after fertilization. As the seed increases rapidly in diameter, the nucellar cavity correspondingly spreads out laterally. This encroachment of the nucellar cavity does not go deeper than the tissues surrounding the chalazal vascular bundles, because this tissue, together with the outer layer of the seed coat, breaks down into a mucilage tissue which swells up (pl. 4, fig. 44). This swelling of the mucilage tissue makes the cavity flat and fungiform instead of subglobose, and the nucellar mass is pushed up against the micropylar region. Simultaneous with this growth of the mucilage tissue, the integument immediately surrounding the micropyle also thickens rapidly, pushing into the cavity to form the micropylar collar (pl. 3, fig. 42; pl. 4, fig. 44 and 45). A cylindrical sheet of tissue of the outer integument throughout its thickness and just above the collar becomes differentiated into an abscission layer which cuts off the micropylar plug (White, 1928). This plug is thus made up of the tissues of the outer integument plus a portion of the vascular bundles, and constitutes the aril-like structure usually found around the micropyle of the mature seed.

In the case of the sterile seeded form of banana, degeneration of the nucellar tissue commences long before fertilization takes place (pl. 3, fig. 43). Soon after the megagametophyte is fully formed in the sac or even after fertilization, the nucellar tissue, together with the inner integument, separates from the outer integument, and leaves a clear space between these two integuments. The seed may continue to develop for some time, and later degenerate.

Embryo. The development of the embryo or zygote has not been followed in detail as the material at hand was too scanty to warrant such a study. However, the zygote does not begin to divide until after endosperm formation is well under way. In fact, White (1928) never saw it divide until six weeks after pollination. The embryo of the mature seed is very small, and does not contain a well defined suspensor. The writers are inclined to believe that the embryo is found in both kinds of seeds, soft as well as hard.

Like White (1928), the writers were not able to follow the course of the pollen tubes from the stigma to the megasporange.

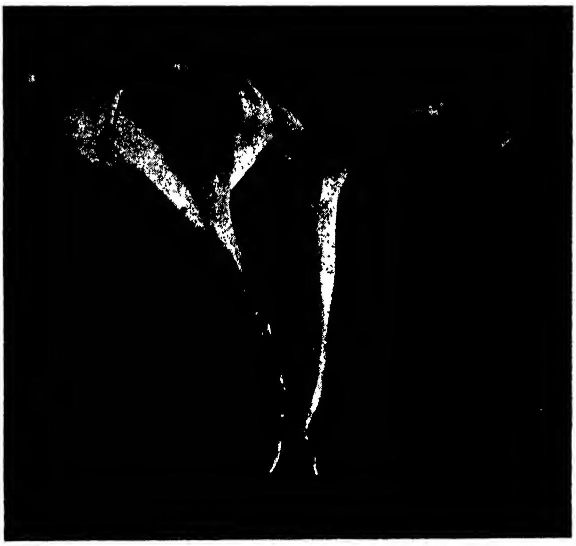

Fig. 1.—Showing two plantlets arising from a single seed. ×1.

Perhaps the pollen tubes follow the glandular canal which penetrates the stigma, enter the micropyle and push through the micropylar pad directly into the embryo sac (pl. 3, fig. 40).

It is interesting to note that the repeated efforts of the writers to discover a case of polyembryony in this variety of banana were not without success. In one sowing of one thousand and seven hundred fifty seeds, a seed was discovered giving rise to two plantlets (fig. 1). The two plantlets were perfectly developed, and nearly identical in size. One may take this as an example of early branching but if such is the case the plumules ought to vary in size and vigor. The writers are inclined to believe that this is another case

of polyembryony in *Musa* (*M. errans* var. *botoan*). The first case of polyembryony ever reported in *Musa* was in *Musa ensete* (Gatin, 1905).

Endosperm. The endosperm in this variety of banana is of the nuclear type similar to that reported in *Musa coccinea* and *M. sapientum* (Tischler, 1913), *Musa basjoo* (White, 1928), Marantaceae (Schachner, 1924) and *Canna indica* (Humphrey, 1896, Wiegand, 1900). In *Ammomum Danielli,* a member of the family Zingiberaceae, Schürhoff (1926) states that Palm reported a "helobiales" type of endosperm. White (1928) believes that this kind of endosperm formation (nuclear) of Philippine seeded banana is probably a characteristic of the fertile *Eumusae* in general. Soon after fertilization, the primary endosperm nucleus begins to enter active divisions. Not all of the daughter nuclei actively divide, as some may enter a resting condition. Some, however, appear to be more active than the others, and continue to divide rapidly, forming isolated groups of endosperm nuclei. The isolated groups of endosperm nuclei may become invested with distinct cytoplasmic wall, and form vescicles which extend into the embryo sac (pl. 3, fig. 40). White (1928) observed that in several cases these groups of endosperm vescicles may themselves become constricted from the parent sac and attach themselves variously to the perisperm wall and develop as separate endosperm masses falsely suggesting apogamous origin of embryos.

At about four weeks after pollination the coenocytic condition of the endosperm disappears and walls begin to form. Wall formation takes place first around the proembryo at the micropylar portion of the embryo sac and progresses downward until the whole nucellar cavity is filled up. In the development of the endosperm, the nucellar tissue is not wholly destroyed, so that a greater portion of this tissue which lines the coats persists in the mature seed. This endosperm in the mature seed usually fills up the whole nucellar cavity as is the case in *Heliconia* (Humphrey, 1896), but in some cases it may fail to form in the central portion of the cavity.

The seeds from the sterile form of this variety of banana may show normal development of endosperm until wall formation and even after. If wall formation ever takes place in their endosperm, they usually fail to show any sign of deposition of starch grains in it. In the mature seeds, therefore, there may be normally developed embryos with endosperm devoid of the starch grains much needed for their normal development. In fact, White (1928) claimed that

failure of the endosperm to form in some seeds he had examined was responsible for their failure to germinate.

Seed coats. When the megaspore mother cell has just finished elongating and is in synapsis, the two integuments are fully differentiated on the megasporange (pl. 4, fig. 49). The inner integument consists of two to three layers of cells in longitudinal section. The outer integument is thicker and consists of several layers of cells, usually about nine or less in number. By the time the megasporange is about to be fertilized, the two integuments grow very rapidly so that they nearly cover the micropyle, the outer integument further increasing in thickness especially near the micropylar region and at the junction between the megasporange and the funiculus (pl. 4, fig. 44).

Outer coat or testa. Before fertilization, the outer integument becomes very massive (pl. 4, fig. 48). Because of the pressure from within, the layers of the cells of the outer integument adjacent to its inner epidermis become flattened longitudinally (pl. 4, fig. 52) except the two or three layers below the outer epidermis. This elongation of the cells of the outer integument becomes more pronounced as the young seed matures. The inner epidermis remains small, while the outer epidermal cells may enlarge somewhat. Later, the outer epidermis elongates radially and unequally at various points on the seed (pl. 4, fig. 45 and 47) and remains parenchymatous. This makes the seed regular in outline when freshly taken from the mature fruit. Being parenchymatous, a slight mechanical pressure will destroy these epidermal cells and expose the hypodermal tissue within. The hypodermal cells, however, never elongate radially, but are compressed by the outer epidermal cells. Instead of elongating radially, they increase their length parallel to the long axis of the seed. At regions where the epidermal cells have not elongated considerably they actually grow in that direction and push themselves outward, rendering, therefore, the outer surface of this hypodermal tissue of the outer coat irregular in outline. Thus, before lignification, the testa consists of (1) radially palisaded or irregularly elongated epidermal cells, (2) a hypodermal region consisting of smaller, many tangentially elongated cells, and (3) inner region composed wholly of elongated cells delimited inside by the small squarish or rectangular inner epidermis.

At maturity of the seed, all the cells enclosed by the outer epidermis of the testa become lignified and constitute the ***shell*** to the seed. The outer epidermis remains parenchymatous and easily

separates from the shell at the slightest pressure from without. If these epidermal cells are not destroyed mechanically, they usually shrivel through rapid loss of water through their walls. Some of the cells of the shell become pitted (pl. 4, fig. 50-51).

The testa of the sterile soft seed shows the same identical morphological structure found in the fertile seed, except that lignification of the shell is rather slight, thus rendering the testa comparatively soft and not resistant to any appreciable pressure from without.

Inner coat or tegmen. The inner integument always maintains its thickness of two cells instead of three as is found in the young megasporange. During the enlargement of the young seed, the tegmen is compressed against the heavily developed testa and its cells flatten out. They become rectangular in shape with their long axes parallel to the length of the megasporange. At some portions the perisperm reaches the inner epidermis of the testa of the seed so that the tegmen at these regions is greatly compressed, and its cells are obliterated leaving only the remnants of their walls (pl. 4, fig. 51). The tegmen, therefore, appears only in alternating regions of the seed just below the testa. These remains of the tegmen become lignified in the mature seed.

The tegmen of the soft seed may persist as compressed cells within the testa and never become lignified to any great extent.

Perisperm. The nucellar tissue of the young seed is not completely absorbed by the developing endosperm and embryo, and remains as distinct tissue below the tegmen of the seed. It consists of large rectangular cells (pl. 4, fig. 51) which are later filled up with abundance of starch grains in the mature seed. On the outer tangential walls of the peripheral cells of this perisperm is deposited a thick callose-like material (pl. 4, fig. 51).

SUMMARY

The terminal, pendant, spicate inflorescence from both forms of *Musa errans* (Blanco) Teodoro var. *botoan* Teodoro differentiates quite early at the apex of the pseudostem, and forms acropetally lateral appendages or bracts in a 3-ranked spiral. In the axils of these bracts the fascicular primordia arise as mammillate humps which bifurcate, and these form the primordia of the 2-rowed flowers in a fascicle. Female or pistillate flowers are borne below, followed by a few clusters of neuter or "pseudo-hermaphrodite" flowers, and the rest of the terminal flowers are male or staminate.

The development of the floral organs of all the three kinds of flowers produced on the inflorescence is acropetal, and they arise as follows: outer perianth lobes, inner perianth lobes, stamens, and pistil. All the outer three perianth lobes together with the two abaxial lobes of the inner perianth form the perigonium, while the remaining inner perianth lobe gives rise to the scale. Nearly all or all of the stamens may abort in the female and neuter flowers, while the pistil becomes degenerated in the neuter and male flowers.

Usually one of the stamens becomes aborted in the male flower, and the functional stamens form filaments and anthers quite early. The archesporial tissue as well as the tapetum arise by simple regional differentiation in the lobes of the anther, and this archesporial tissue functions direct as the microspore mother cells. The tapetal cells which are at first uninucleate, become binucleate at the time the microspore mother cells have completed dividing. The tapetum and a greater portion of the parietal tissue are crushed and destroyed during the growth of the microspore mother cells. Only the outer layer (endothecium) and the layer of cells below this persist in the mature anther.

The microspore mother cells divide successively, and linear or tetrahedral forms of tetrads are developed. Degeneration of microspores are noted, and many of the microspores possess supernumerary tube nuclei before they are dehisced.

The individual macrosporange starts as a mammillate outgrowth from the axillary placenta, and this grows at a right angle to the ovary wall. By one-sided growth the megasporange becomes anatropous, with its micropyle pointing in all directions. By the time the inner integument is fully formed, a single hypodermal archesporial cell differentiates at the summit of the nucellus of the megasporange, which divides periclinally into an outer primary parietal cell and an inner megaspore mother cell. The primary parietal cell does not become very active, so that usually one, two or three layers of parietal tissue intervene between the nucellar micropylar epidermis and the megaspore mother cell. The megaspore mother cell by two successive divisions forms a row of four daughter megaspore cells, the chalazal megaspore of which becomes functional. Formation of three megaspores is not uncommon in this variety of banana.

A normal seven-celled megagametophyte is formed. The synergids and antipodals may remain in the sac until after fertilization.

The zygote remains dormant long after fertilization and this gives rise to a small embryo in the mature seeds.

The endosperm is of the nuclear type, and its development follows that of many of the angiosperms. It usually fills completely the nucellar cavity, and is not totally absorbed by the embryo at maturity of the seed. In the soft seeds of the sterile form of this banana the endosperm fails to store starch grains at maturity. The nucellar tissue is not totally destroyed by the enlargement of the nucellar cavity, and this remains in the mature seed as the perisperm.

The ovary wall of the pistil very early differentiates into two distinct regions or layers; namely, (*a*) an *exocarp,* and (*b*) an *endocarp.* The endocarp contributes to the formation of the edible portion of the fruit, while the exocarp forms the skin or peel of the same fruit. In parthenocarpic varieties even the aborted seeds form a part of the sum total of the fleshy edible portion of the fruit.

Pollination is necessary for the proper development of the fruit in this seedy variety of banana.

The development of the seed is described. The outer integument of the megasporange gives rise to the outer soft, juicy and translucent outer covering of the seed which easily sloughs off, and to the hard shell within this. The inner integument may persist in the mature seed as a thin, lignified tissue below the shell. The seed of the sterile form possesses an embryo devoid of a well developed endosperm, and this is responsible for its inability to germinate. The softness of the seed in this form is mainly due to the fact that very early after fertilization or even before, the inner integument together with the nucellus may collapse and actually separate from the outer integument. The outer integument develops as usual, and while the seed may appear normal from the outside, it is actually devoid of contents, hence, is sterile.

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EXPLANATION OF THE PLATES

Parts of the inflorescence, the flower, the fruit and the seed are designated as follows: antipodals (*an*), bract (*b*), carpel (*c*), megagamete (*e*), endothecium (*ed*), embryo (*em*), endosperm (*end*), funiculus (*f*), fascicular primordium (*fp*), inner coat or tegmen (*ic*), inner integument (*ii*), inner perianth lobes (*ip*), micropylar plug (*mp*), mucilage tissue (*mt*), nucellus (*n*), nucellar mass (*nm*), outer coat or testa (*oc*), outer integument (*oi*), outer perianth lobes (*op*), floral primordium (*p*), palisaded epidermis of the testa (*pa*), perisperm (*pe*), polar nuclei (*pn*), perigonium (*pr*), pollen tube (*pt*), stamens (*s*), scale (*sc*), shell (*sh*), staminodium (*st*), synergid (*sy*), tannin cells (*tc*), endosperm vescicle (*vs*), and zygote (*zy*).

PART I

(Fig. 1, 7–8, and 11 are from the soft-seeded form; the rest from the hard-seeded).

Fig. 1. Portion of the longitudinal section of the young inflorescence showing the bracts, fascicular primordia and floral primordia. × 18.4.

Fig. 2. Longitudinal section of a male floral primordium showing the outer perianth lobes already cut off. × 43.5.

Fig. 3. An older male flower with the inner perianth lobes well differentiated. × 43.5.

Fig. 4. Longitudinal section of a male flower showing the outer and inner perianth lobes, and the stamens already formed. × 43.5.

Fig. 5. Longitudinal section of an older male flower showing the carpels. × 43.5.

Fig. 6. An old male flower with all its parts fully differentiated. This was cut through the dotted line in fig. 8. × 25.

Fig. 7. Transverse section of the male flower near its apex showing the relative positions of the stamens, outer perianth segments, inner perianth segments, and the scale. × 65.

Fig. 8. Transverse section of an older male flower cut near the apex of the ovary showing the carpel, stamens, staminodium, scale, and perigonium. × 43.5.

Fig. 9. Axial view of a single neuter flower with scale removed. × 0.75.

Fig. 10. Axial view of a female flower with the scale removed. × 0.75.

Fig. 11. Lateral view of a female flower with two of its stamens functional. × 0.75.

Fig. 12. Lateral view of a male flower. × 0.75.

PLATE II

Fig. 17 and 27 are from the soft-seeded form; the rest are from the hard-seeded form).

Fig. 13. Longitudinal section of a young megasporange showing the archesporial cell; note the inner integument. × 530.

Fig. 14. Longitudinal section through a megasporange showing the archesporial cell divided, forming an outer primary parietal cell and an inner megaspore mother cell. × 530.

Fig. 15. An older megasporange showing enlargement of the megaspore mother cell. × 530.

Fig. 16. A much older megasporange with the megaspore mother cell in synapsis. Note the thickness of the parietal tissue, and the elongation of the epidermis of the nucellus. × 530.

Fig. 17. Portion of the transverse section of the ovary showing the anatropous megasporange with its two integuments and the filamentous outgrowths from its funiculus. × 56.

Fig. 18. Showing first division of the megaspore mother cell. × 530.

Fig. 19. Two megaspore cells. × 530.

Fig. 20. Showing one of the two megaspore cells degenerating. × 530.

Fig. 21. A row of three megaspore cells, the two micropylar ones degenerating. × 530.

Fig. 22. Tetrad. × 530.

Fig. 23. Uninucleate megagametophyte. × 530.

Fig. 24. Binucleate megagametophyte. × 530.

Fig. 25. Binucleate megagametophyte; polarity. × 530.

Fig. 26. Quadrinucleate megagametophyte. × 530.

Fig. 27. Mature megagametophyte showing the magagamete, synergids, polar nuclei and the antipodal. × 530.

PLATE III

(Fig. 28, 40, 42–43 are from the hard-seeded form; the rest are from the soft-seeded form).

Fig. 28. Transverse section of the ovary of the neuter flower showing the generated loculi. × 12.5.

Fig. 29. Diagram of a transverse section of an anther of the male flower. × 117.5.

Fig. 30. Transverse section of anther showing the archesporial tissue or microspore mother cells and the tapetum. × 530.

Fig. 31. Transverse section of an older anther showing the microspore mother cells beginning to round off; the tapetum separating from the parietal tissue. × 530.

Fig. 32. Microspore mother cell in synapsis. × 530.

Fig. 33. Dyad. × 445.

Fig. 34. Linear tetrad. × 445.

Fig. 35. Tetrahedral tetrad. × 445.

Fig. 36. Linear tetrad. × 445.

Fig. 37. Young microspore before division of its nucleus. × 530.

Fig. 38. Microspore before dihiscence. × 270.

Fig. 39. Mature microspore showing seven tube nuclei and a single generative nucleus. × 270.

Fig. 40. Embryo sac showing the zygote on the side of which is the pollen tube; endosperm formation is on; note the endosperm vescicle at the antipodal region of the embryo sac. × 245.

Fig. 41. Longitudinal section of a portion of a mature anther showing its epidermis, endothecium and remains of the parietal tissue. Note the microspores. ×245.

Fig. 42. Median section of the megasporange to show parts. × 49.5.

Fig. 43. Median section of a megasporange showing shrinkage of the nucellus and the inner integument. × 49.5.

PLATE IV

(Fig. 49 and 53 are from the soft-seeded form; the rest are from the hard-seeded form).

Fig. 44. Longitudinal section of a young seed showing the position of the embryo sac and the nucellar mass. × 23.5.

Fig. 45. Longitudinal section of an older seed showing its parts. Dark portion shows lignification. × 10.

Fig. 46. Portion of the transverse section of the mature pericarp showing the separation point between the exocarp and the endocarp. Note the presence of starch grains in the endocarp. × 43.5.

Fig. 47. Portion of the longitudinal section of a nearly mature seed showing the palisaded epidermis and the hypodermal sclerenchymatous cells of the shell. × 270.

Fig. 48. Portion of the longitudinal section of the young megasporange showing its integuments and part of the nucellus. × 245.

Fig. 49. Portion of a longitudinal section of a young megasporange showing the two integuments fully developed. Ovule has megaspore mother cell in synapsis. × 245.

Fig. 50. Portion of the longitudinal section of a nearly mature seed showing the inner longitudinally elongated cells and the outer smaller cells of the shell (from outer coat or testa). × 270.

Fig. 51. Portion of a longitudinal section of a nearly mature seed showing the persistent inner coat or tegmen. × 270.

Fig. 52. Portion of the longitudinal section of a young seed showing the immature testa and tegmen, and a portion of the perisperm. × 245.

Fig. 53. Portion of the transverse section of the pericarp showing the formation of air spaces in the endocarp. × 205.

Fig. 54. Transverse section of the pericarp showing differentiation of the exocarp and the endocarp. Note the absence of vascular bundles in the endocarp. × 205.

Fig. 55. Portion of the transverse section of an older pericarp showing much more decided differentiation of the exocarp and endocarp. Note the formation of air spaces in the endocarp. × 205.

PLATE V

Fig. 56. Showing mature bunch of fruits from the hard-seeded form. × 0.05.

Fig. 57. Showing the effect of bagging on the production of fruits (hard-seeded form). × 0.05.

Fig. 58. Showing persistence of the bracts. Fruits have dropped off. × 0.05.

Fig. 59. Showing the effect of clipping off the stigmas and natural pollination on fruit production. × 0.125.

Fig. 60. A hand which had never been clipped or artificially pollinated. × 0.125.

Fig. 61. Showing the effect of clipping off the stigmas and artificial pollination. × 0.125.

Fig. 62. Nearly mature bunch of soft-seeded form showing the effect of clipping on fruit production. Note the small fruits that had been clipped. × 0.125.

Fig. 63. Showing young seedlings from the hard-seeded form. × 0.33.

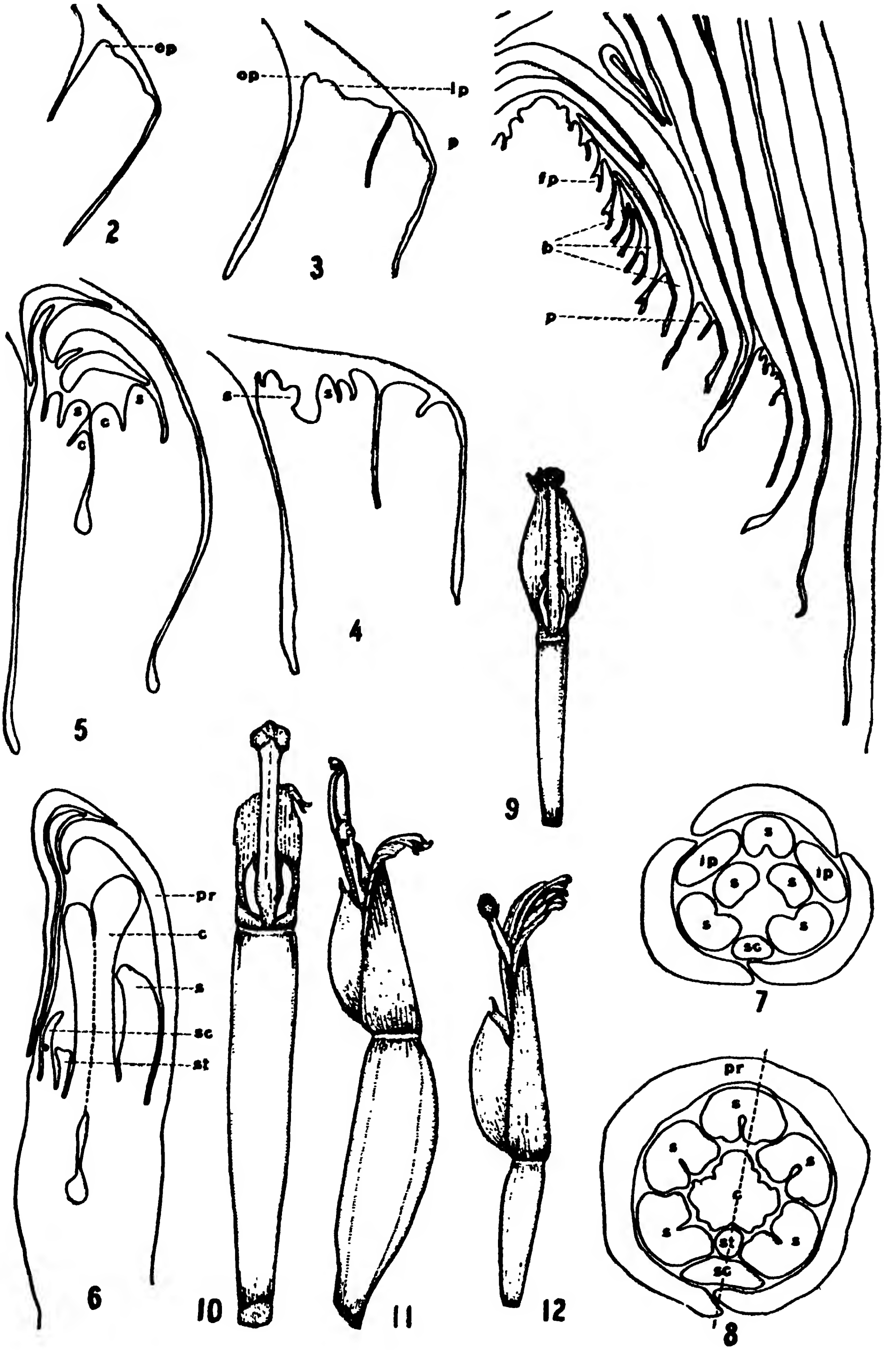
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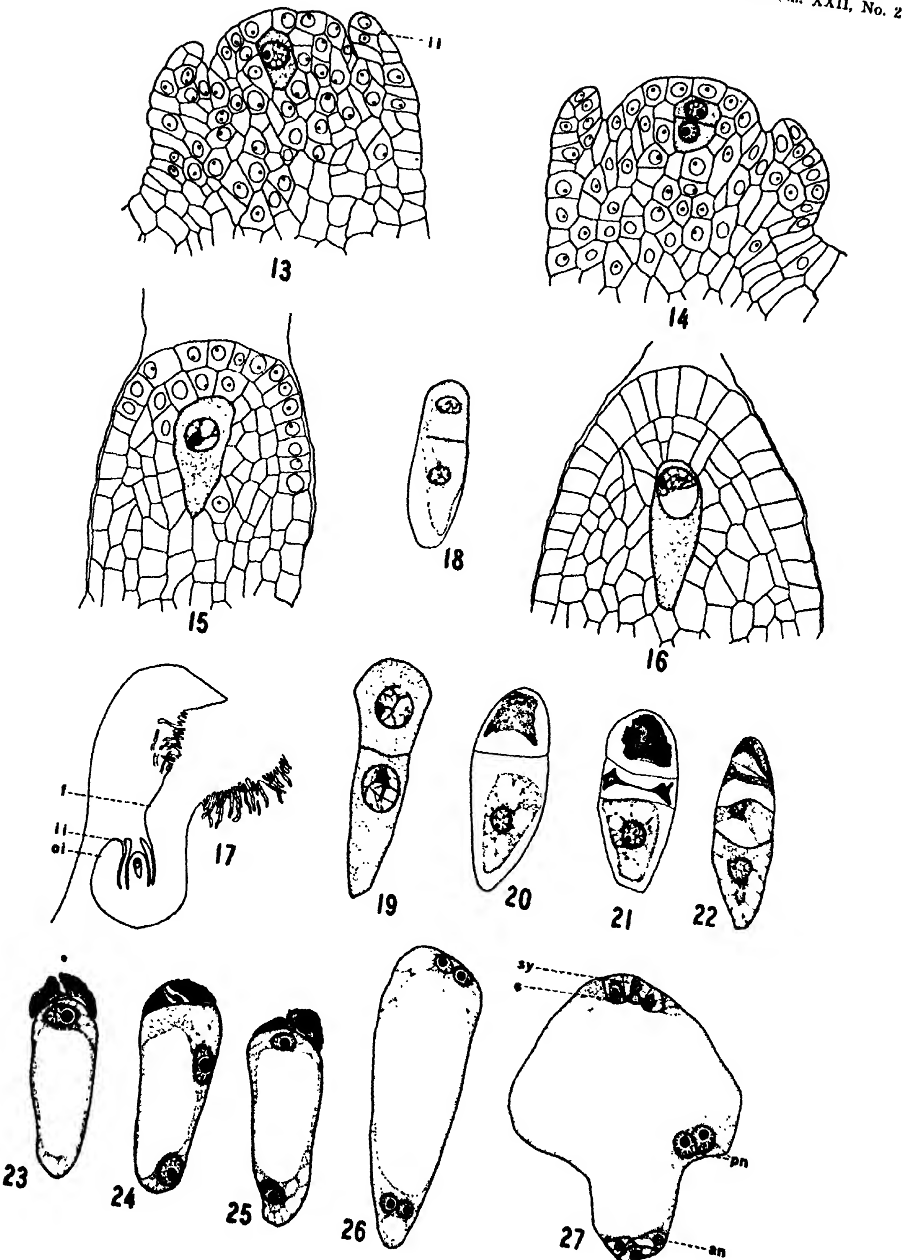
PLATE I



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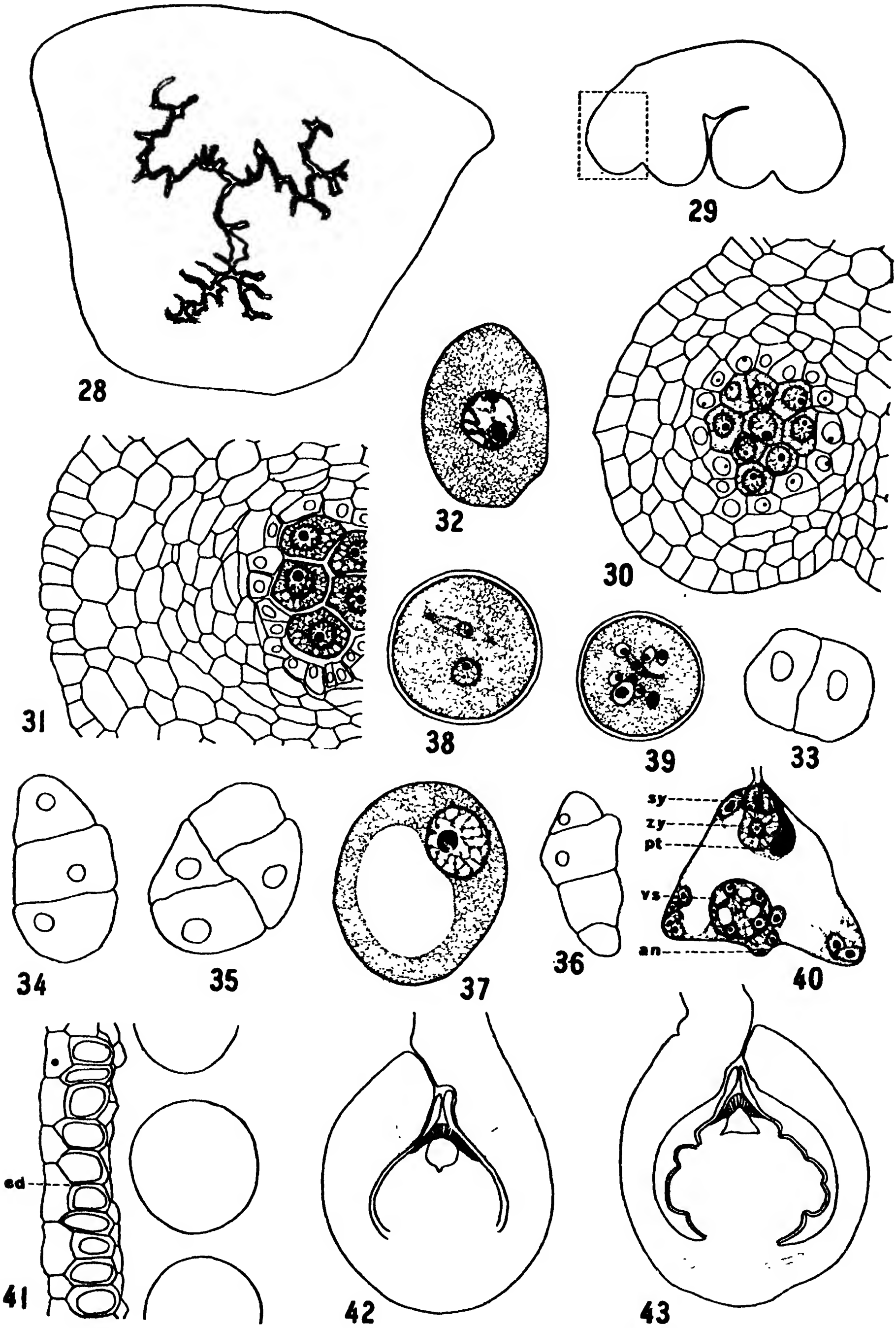

PLATE III

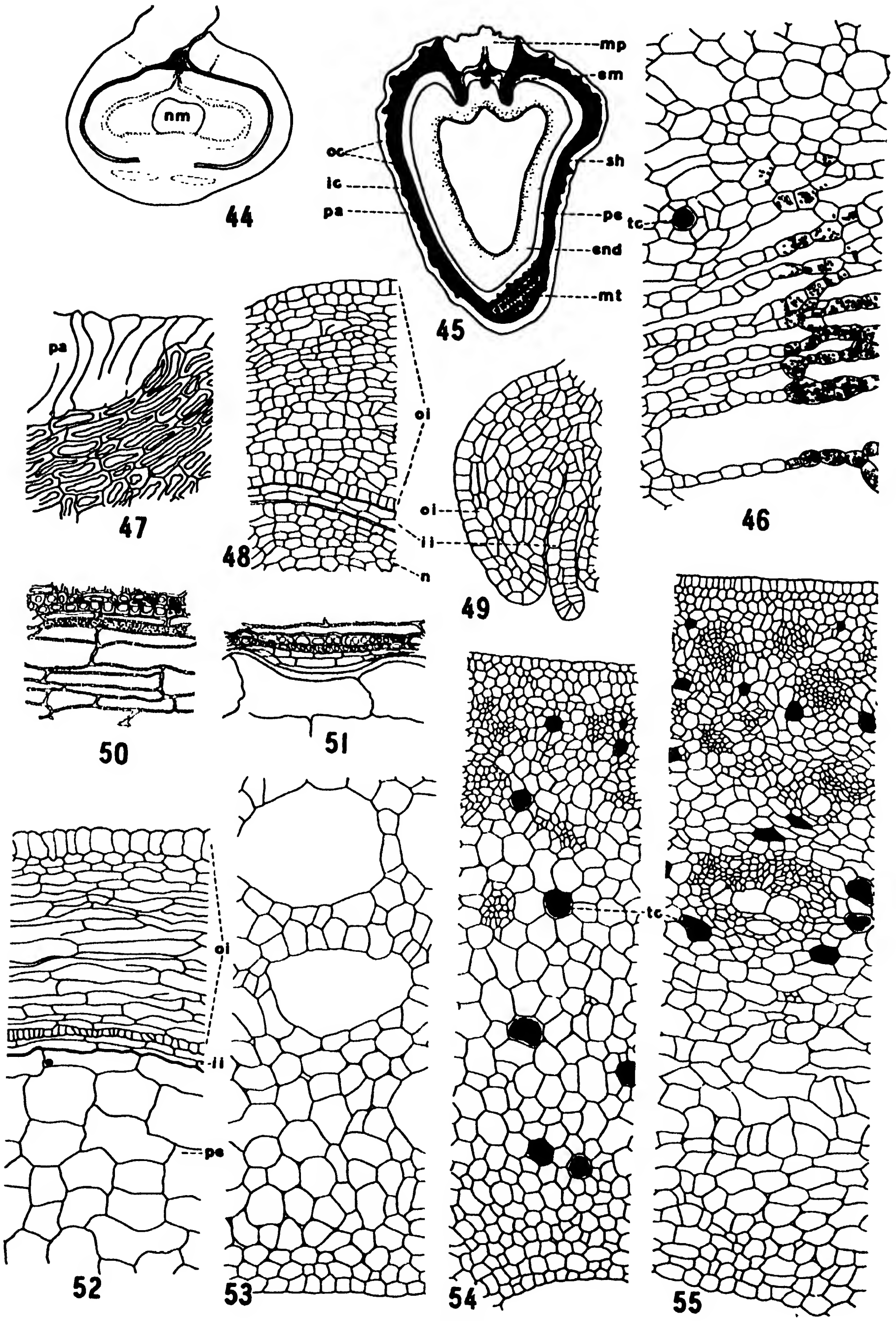

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PLATE IV

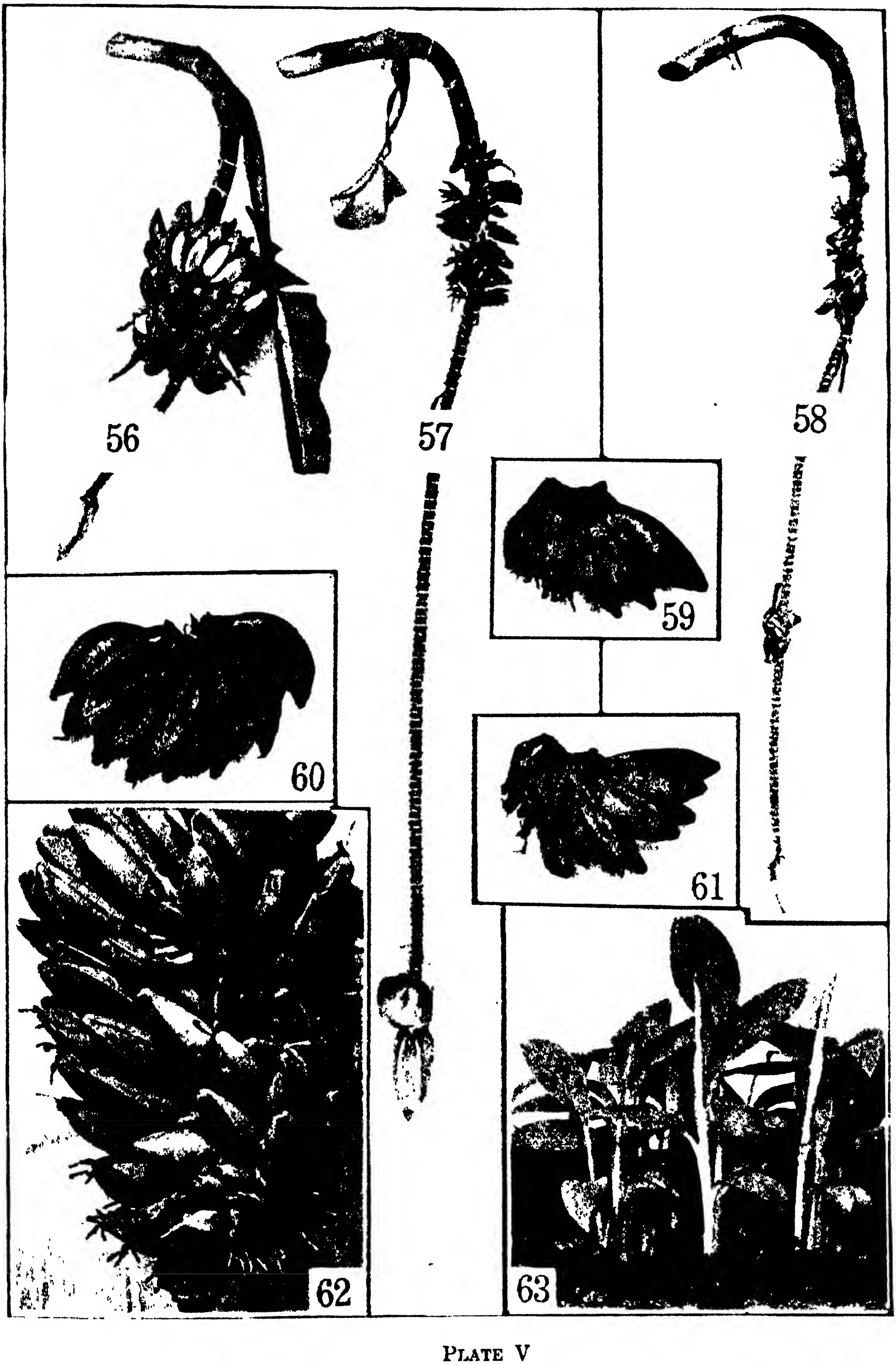

PLATE V

COST OF PRODUCTION OF LOWLAND RICE IN THE COLLEGE OF AGRICULTURE [1]

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Of the Department of Agricultural Engineering

INTRODUCTION

Viewed from the standpoint of economic importance, rice is undoubtedly one of the most important crops of the Philippines. It is not only the principal food of the people but is also the principal feed for live stock. Statistics show that in the Philippines this is the crop that exceeds in quantity all the other cultivated grains taken together. Many studies and experiments have been conducted with a view to improving its culture and increasing its production. Among the most important studies are those on seed selection, fertilization, standardization of commercial rice, acclimatization of introduced high yielding varieties, and survey of cost of production in various rice regions of the Islands.

Cox (1920) defines the cost of production in three ways: (1) More strictly speaking, the term "cost of production" is applied to the labor, the pains undergone either in producing or in waiting for the fruits of toil. (2) Cost of production may be used in the sense of opportunity cost; opportunity cost means that the farmer could have been doing something else. (3) Cost of production is most frequently used in this sense of expense of production; that is, money cost. Cost of production used in this sense includes every expense of whatever nature, whether overhead or operating expenses, necessary to obtain the product.

The cost of production must be known in order to put the farming business on a sound basis and, if possible, make it a profitable enterprise. Every farmer ought to know at all times how much a particular crop cost him to produce, so that he can be in a position to talk intelligently about it as a successful business man is able to do. Business men usually know what it costs them to acquire certain goods before they offer them for sale. Otherwise, they could not fix a price that would make a satisfactory gain.

[1] Portions of the material in this paper were presented by the junior author in his thesis presented for graduation, 1933, with the degree of Bachelor of Science in Agriculture, from the College of Agriculture No. 349; Experiment Station contribution No. 891.

The study of the cost of production gives useful information on the farming methods followed in a certain locality, thus better economic farming operations may be accomplished.

In the Philippines, very few studies have been made on the cost of production of rice. As to methods of investigation, some investigators worked by cost accounting, others by personal interview and some others by questionnaires. The present investigation was made by cost accounting and personal interview methods. No matter what method was used most of the investigators claim that the cost figure they used in determining cost of production of a certain crop was not definite and specific. Factors of production differ widely on different farms and even in the same place variation has been noticed from season to season.

Sacay (1927) reported that rice crops cost the Pangasinan farmer an average of 2.54 capoñgos of seed, 56.91 days of man labor and 14.96 days of animal labor. In Nueva Ecija, he found that it cost the farmer an average of ₱3.05 to produce a cavan of rice. And in this province a hectare of land requires 20.5 gantas of palay seed and ₱66.33 worth of labor.

Isidro (1919) compared the costs of producing upland and lowland rice in the College of Agriculture, in Maahas and in Anos, Los Baños, Laguna. He reported that the cost of production per hectare was ₱83.35 for lowland rice in Maahas and ₱67.31 for upland in Anos. As to cost of production per cavan, he stated that it cost ₱2.60 for lowland and ₱2.63 for upland rice. He claimed that the results in the College cultures were not conclusive. He reported that the cost of production was ₱154.73 per hectare for lowland rice and ₱145.25 for upland.

The objects of this work were to determine the cost of production per cavan of lowland rice grown according to the method used in the College of Agriculture which is representative of the methods followed in the vicinity of Los Baños, Laguna, and to determine the net gain per hectare in this farm enterprice.

The cultural operations were begun in August, 1932, and were finished in February, 1933. The study was conducted in the lowland rice fields of the College of Agriculture, Los Baños, Laguna.

MATERIALS AND IMPLEMENTS

Land

The land used is owned by the College of Agriculture, University of the Philippines. It is divided into fields and these fields are subdivided into paddies. Each field is farmed by a farmer who provides

the capital. As his share he gets four-fifths of the harvest left after deducting the share of the harvesters and threshers. The other fifth goes to the College as its share. The lowland rice fields under study have a total area of 31.0716 hectares. There is no controlled irrigation system but irrigation water is supplied by two creeks, the Maitem and the Boot, which have their sources on Mount Maquiling. Draining the field is not a problem as the land is sloping.

Seeds

The amount of seed used to plant 31.0716 hectares was 275 gantas or 29 cavans, an average of 23.32 gantas per hectare. The seeds came from the Farm Crop Division of the Agronomy Department. The varieties of rice used were, Elonelon and Ramai, which are classified as late maturing varieties. They mature in from 150 to 160 days under Los Baños conditions. They are considered as high yielding varieties, especially the Ramai. Both are introduced varieties in the Islands and are acclimatized in this place.

Plows and harrows

Homemade plows were used. Teodoro (1925) stated that some parts of the native plow, as the moldboard and the share, are bought as separate pieces and other parts as the beam, the handle, the moldboard support and the landside are usually cut by the farmer himself from hard trees in the forest. He further stated that an expert usually charges from ₱4.50 to ₱5.00 for labor cost in constructing the plow. The finished plow costs the farmer from ₱10 to ₱25 depending upon the quality of the materials used. A plow that has been used and proved to work well commands a higher price, usually from ₱25 to ₱30. Catambay (1931) gives the cost price including the accessories of a native plow of the upland type, as ₱17.

The harrows used were the native peg tooth harrow or *calmot* and the native comb tooth harrow, the *suyod*. The calmot is made of bamboo stumps fastened together with a short portion of a branch in the node left uncut, projecting, to serve as teeth. The suyod is shaped like a comb with 13 steel teeth about 25 centimeters long and spaced 15 centimeters apart. The usual price of the calmot is ₱5.00 and the suyod, ₱9.00. Each of these native implements, the plow, the calmot and the suyod are pulled by one carabao.

CULTURAL METHODS

In the Philippines there are two methods usually followed in growing rice; namely, the direct planting and the indirect. In the direct method, no seed bed is used. All upland varieties of rice

maturing in from 90 to 140 days are planted by the direct method. Occasionally, lowland rice varieties are also planted directly into the field, thus avoiding the expenses incurred in the preparation of seed bed and in transplanting.

In the indirect planting, the seed bed is necessary. This method is used with the lowland rice varieties. Indirect planting was used in the present work, as it dealt with cost of producing lowland rice. The requirements of a good seed bed are: (1) the soil must be light, fairly rich and easily worked; (2) it must contain abundant moisture; (3) soil must be thoroughly prepared, free from weeds and trash before the seeds are sown; (4) it must be fenced; and (5) if possible it should be so located that it can be watered or drained at any time.

Preparation and planting of the seed bed

Plowing, harrowing and cleaning. The total area of seed bed plots prepared was 14,813.92 square meters or 1.4814 hectares. The plots were plowed one time with a native plow. After plowing, the dikes were repaired and cleaned with a bolo. Then about two or three days after plowing, harrowing was begun; a suyod was used. The bed was harrowed from three to six times depending upon the quantity of grass and trash present and the character of the soil puddle. When the soil was thoroughly puddled, it was leveled with the suyod stuck into a banana stalk about 1.5 meters long. After leveling, the seed beds were fenced with one strand of barbed wire set about one meter above the ground and fastened to posts about two meters apart.

Sowing. The seeds were placed in sacks and soaked in water for about 24 hours, then placed in the shade, covered with trash and left for three days. By this time the seeds had germinated and were ready for broadcasting. The sowing was done by a man who could broadcast the seed fairly uniformly. During the growing period of the seedlings water was kept in the seed bed. Rain was the main source of irrigation.

Preparation of the field

Plowing. After preparing the seed beds, the farmer turned his attention to the preparation of the field. The first operation was plowing which was done with the native plow when the field was submerged in water. In many cases after plowing, the field was left for about two weeks without touching it because of the lack of water. The plowed fields dried up, baked, sometimes cracked so

that the next operation which was harrowing was difficult, although the field had again been submerged in water. In some cases a second plowing was necessary.

Repairing the dikes. Right after plowing, the dikes were repaired and cleaned. The parts of the dikes destroyed during plowing were filled up with clods from the furrow slices.

Harrowing. The first harrowing was done lengthwise with the field submerged in water. If the field was thickly covered with weeds, the calmot was used first to crush them in the soil. This first harrowing was to break the large clods of soil. After a few days the field was harrowed lengthwise; the object was to puddle the soil thoroughly, and at the same time level the field. These three operations were made with the fields covered with water, otherwise the puddling would not be thorough.

Transplanting

Pulling up and bundling the seedlings. About 40 days from the time the seeds were sown, the seedlings were pulled up by hand and bundled. The soil that stuck to the root systems was shaken off by striking the base of the seedlings against the toes before the seedlings were bundled. The seedlings were set on a small circular piece of board supported by a long peg so that the base of the seedlings were at the same level. The bundles were tied with bamboo fibers, each bundle being about five centimeters in diameter. After bundling, the seedlings were topped to about 20 centimeters in length by sliding the bundles against the sharp edge of a bolo mounted on a support and held firmly. The bundles were then taken to the field on a sled pulled by a carabao and piled along the dikes of the paddies to be planted.

Transplanting. The planters, men and women, planted an average of four seedlings to a hill with an estimated spacing of from 15 to 20 centimeters each way. The bundled seedlings were distributed and given to the planters by women. The planters and those distributing the seedlings were provided with food by the farmer.

Care of the standing crops

Draining and irrigating. A week after transplanting, some of the paddies were visited to drain off the water if they were too full and to turn it on if there was too little. Inasmuch as the source of water was rain the farmers were careful to prevent leakage through the dikes.

Fertilizing. Some of the fields under survey were fertilized by thesis students in the Farm Crops Division using ammonium sulfate, Ammo-phos, Corona No. I and Corona arroz. Ammonium sulfate and Ammo-phos were applied to a field with an area of 14,998 square meters, divided into halves and one half was treated with ammonium sulfate and one half with Ammo-phos. Corona No. I was applied to another field with an area of 9,034 square meters and Corona arroz to a field of 9,412 square meters. The fertilized fields were divided into lots and each lot was treated with a different rate of application. These rates were 100, 150, 200 and 250 kilograms per hectare. The fertilizers were broadcast into the fields two weeks after the transplanting. Before applying the fertilizers, the dikes were repaired so that water could not flow from lot to lot and thus lose the fertilizers.

Weeding. A month or more after transplanting the fields were partially weeded. Only the paddies where weeds grew faster than the rice plants were weeded. The dikes were occasionally cleaned by cutting the weeds with a bolo.

Driving away the birds. One of the worst enemies of rice are the birds commonly called *mayas*, the Philippine weaver bird called *mayang pula*, (*Munia jagori* Martens) and the Java sparrow called *mayang costa* (*Padda oryzivora* Linn.). The simplest way to control these pests is to drive them away. A small hut roofed with coconut leaves was constructed in the middle of each field. Then lines from 50 to 100 meters long, depending upon the size of the field, were put up. One end was attached in the hut, and long bamboo poles spaced about 15 meters apart, tied along the line stretched across the field. On the top of the poles were fastened petroleum cans which made a considerable noise when the lines were pulled by a boy in the hut whenever he saw a flock of birds coming. The noise scared the birds away. The driving away of the birds was carried on from 6:00 to 10:00 a. m. and 3:00 to 5:00 p. m. from the milking stage of the plants up to harvesting time.

Harvesting

Method of harvesting. Harvesting, which was by hand, started in January and was finished in February. Men, women and children were employed. Africa (1919) classifies the various methods of hand-harvesting of rice as follows: (*a*) Cash payment system; (*b*) part cash, part share payment system; (*c*) share payment system.

In this work the share payment was used. In harvesting, the rice plants were cut off about half way between the head and the base of the plants with the *yatab* or *pangani*, which is a handy implement with a blade about 13 centimeters long and 4 centimeters at the widest part. It is fastened at the middle of a handle made of cylindrical piece of wood about 12 centimeters long and about 3 centimeters in diameter, the size depending upon the owner. The rice was cut usually just below the last node of the panicles from 10 to 15 centimeters below the grain. The cut heads were left piled on the rice straw. After the grain was cut these piles were gathered into one big pile in the place where threshing was done.

Threshing

Method of threshing. Threshing was done after the cut panicles were gathered into the big pile. Men and women did the threshing by trampling upon the cut panicles placed on buri mats.

Cleaning and curing

After separating the grain from the head, the straw and chaff were separated from the grain by hand picking and winnowing. When cleaning was finished, the palay was sacked and carried to the huts where it was divided in shares by volume, that is, one-fifth went to the harvesters and threshers. The remaining four-fifths were divided again into five parts and one part went to the College as its share. The farmer delivered the College share to the College bodega. The grain which was turned in by the farmer was not thoroughly dry and clean. The final drying and cleaning of the College share were done at the expense of the College.

EXPERIMENT AND RESULTS

The results of this experiment are presented in tables 1 to 9. Table 1 shows the labor requirements in preparing the seed bed plots. It may be observed from this table that there were twenty seed bed plots with a total area of 14,813.92 square meters or 1.4814 hectares. With the native plow the beds were plowed in 147.25 hours; their dikes were repaired in 36.5 hours; they were harrowed with a lowland harrow in 152.5 hours; leveled in 40 hours; and were fenced with one strand of barbed wire in 76.5 hours. The seed bed plots required 725 gantas or 29 cavans of seed which was treated in 31.5 hours and sown in 28.67 hours.

Table 2 shows the labor requirements in preparing the land. It is shown in this table that with the native plow a total area of 31.0716 hectares was plowed in 2611.5 hours; harrowed three times with the lowland harrow in 2838 hours; dikes were repaired in 608 hours; and cleaned with the bolo, in 207.5 hours.

The cost of transplanting rice seedlings is shown in table 3. The seedlings from 29 cavans of seeds sown in seed bed plots, as shown in table 1, were pulled up and bundled in 482 hours with a total labor cost of ₱104.63. They were topped with the bolo in 102.5 hours at a cost of ₱10.25. Hauling seedlings to the fields required 145.5 man hours and 53.5 animal hours with a total cost of ₱19.90; distributing seedlings to the planters required 476.5 man hours with a labor cost of ₱23.83. The total area of 31.0716 hectares, as shown in tables 2 and 3, was planted with rice seedlings in 1966.5 hours. at a labor cost of ₱127. The cost of subsistence in planting this area was ₱103.23. The total cost of transplanting was ₱254.06.

Table 4 shows the data on harvesting and threshing. It may be observed in this table that the crop covering an area of 31.0716 hectares was harvested and threshed in 7407.5 hours by 1759 harvesters and threshers. The actual production obtained was 1902.10 cavans. One-fifth of this production was 380.42 cavans, the share of the harvesters and threshers. This share cost ₱760.84 at 2 pesos per cavan.

The cost of the different farm operations for 31.0716 hectares and for one hectare are shown in table 5. On the basis of one hectare the total cost of the different operations in preparing the seed bed plot was ₱2.72. Of this, plowing cost ₱0.94; harrowing, ₱0.98; repairing dikes, ₱0.11; leveling, ₱0.26; treating seeds, ₱0.10; seeding, 0.09; and fencing, ₱0.24.

In the preparation of the land the plowing cost per hectare was ₱16.48; harrowing, ₱18.26; repairing dikes, ₱1.97; and cleaning dikes, ₱0.92.

Pulling up and bundling rice seedlings to be planted to one hectare cost ₱3.41; topping seedlings, ₱0.33; transporting, ₱0.60; distributing to planters, ₱0.75; and planting, ₱7.20.

On the basis of one hectare the cost was ₱0.08 to partly drain and irrigate the fields; to partly fertilize, ₱0.57; to drive away the birds, ₱0.49; and to harvest and thresh the crop, ₱24.49. The cost of harvesting and threshing was based on one-fifth of the total harvest valued at ₱2.00 per cavan. The total labor cost of the different

farm operations for 31.0716 hectares was ₱2439.73. This makes ₱78.35 as the computed labor cost per hectare.

The supplies and land costs are shown in table 6.

The cost of seeds to plant 31.0716 hectares was ₱116. The cost per hectare was ₱3.73.

The total cost of fertilizers applied was ₱32.08, or ₱1.03 per hectare.

The rent of land was based on ₱20.00 per hectare a year, which was the prevailing rate in Los Baños, Laguna. The total land cost for the area cropped was ₱621.43. The total cost of supplies and land for 31.0716 hectares was ₱769.51 or ₱24.76 per hectare.

TABLE 6

Supplies and land costs
(31.0716 Ha.)

ITEMS	TOTAL COST	COST PER HECTARE
	pesos	*pesos*
Land	621.43	20.00
Seeds	116.00	3.73
Subsistence for transplanting .	127.06	4.09
Fertilizers	32.08	1.03
Total	896.57	28.85

Table 7 shows the depreciation of implements and interest on the investment for 31.0716 hectares. The total implement cost for the area was ₱19.60 or ₱0.63 per hectare.

In computing the charges for the implements the formulas by Catambay (1931) were used. These are:

$$\text{Depreciation in pesos} = \frac{cd}{ym}$$

$$\text{Interest in pesos} = \frac{crd}{365}$$

where c = cost of implement or machinery
d = number of 9-hour days used
m = maximum number of days used in one year
y = number of years of life of the implement or machinery
r = annual rate of interest

Table 8 shows the cost of production. The labor cost, the supplies and land costs, and the implement cost per hectare are shown in this table. The labor cost, supplies and land costs, and implement cost were ₱74.95, ₱28.85 and ₱0.63, respectively, making a total of ₱104.43 as cost of production per hectare. The average production per hectare was 61.22 cavans. The cost of production per cavan was ₱1.71.

TABLE 8

Cost of production

Labor cost per hectare	₱74.95
Supplies and land costs per hectare	28.85
Implement cost per hectare (Depreciation and interest)	0.63
Total cost of production per hectare	₱104.43
Average production per hectare	61.22 cavans
Cost of production per cavan	₱1.706

Table 9 shows the cost of production borne by the farmer. The labor cost was ₱74.95 per hectare. The total cost of production per hectare was ₱104.03. The average production per hectare was 61.22 cavans. The cost of production was ₱1.6990 per cavan.

TABLE 9

Farmer's cost of production

Labor cost per hectare	₱74.95
Supplies cost per hectare	8.85
Land cost per hectare (value of College share of 9.8 cavans or 1/5 the amount left after deducting share of harvesters and threshers which was 1/5 of total production)	19.60
Implement cost per hectare	0.63
Total cost of production per hectare	₱104.03
Average production per hectare	61.22 cavans
Farmer's cost of production per cavan	₱1.699

DISCUSSION OF RESULTS

Labor requirement per hectare

On account of the financial status of the College farmers they hired as little labor as possible. Most of the plowing and harrowing was done by exchange of labor. Thus, by mutual understanding, they grouped themselves with their own animals and implements and worked first one field then another until the operation was

finished. By making a work schedule among themselves, they performed their field operations according to the season. The total number of hours, however, put in by these farmers on each field was recorded so as to determine the labor requirement for each operation.

Table 5 shows the itemized labor requirement per hectare for the different farm operations. It may be observed that the total number of hours required to prepare a seed bed plot for one hectare of land was 27.35. This time was distributed as follows: plowing, 4.74 man and 4.74 animal hours; repairing of dikes around seed bed plot, 1.11 man hours; harrowing, 4.91 man and 4.91 animal hours; leveling, 1.29 man and 1.29 animal hours; treating seeds, 1.01 man hour; sowing, 0.92 man hour; and fencing, 2.43 man hours. It may be seen in table 1, that the total area of seed bed plots prepared was 14,813.92 square meters and in table 2 that the total area of the land to be planted with the seedlings was 31.0716 hectares. The area of seed bed plot, therefore, was 476.77 square meters for one hectare of land.

It required a total of 379.51 hours per hectare including both man and animal labor to prepare the land. The time was distributed as follows: plowing, 84.94 man and 84 animal hours; repairing of dikes, 19.57 man hours; harrowing, 91.33 man and 91.33 animal hours; and cleaning dikes, 9.20 man hours. It may be noted that the number of hours required to plow a hectare was rather high. This was because some of the fields required a second plowing owing to there being little rainfall which resulted in the drying up and baking of these fields.

The planting per hectare required a total of 103.83 hours distributed among the following operations: pulling up and bundling of the seedlings, 15.51 man hours; topping seedlings, 3.29 man hours; transporting seedlings, 4.68 man hours and 1.72 animal hours; distributing bundled seedlings, 15.34 man hours and transplanting, 63.29 man hours.

Draining and irrigating required only 0.83 man hours, because most of the water supply was rain. On an average, only 5.71 man hours per hectare were spent on weeding.

Harvesting and threshing which were done by women, men and children required 238.40 hours per hectare. This item was second to the land preparation in the length of time consumed. Although the expenses for harvesting were based on the share basis, the actual number of hours required to harvest and thresh the rice crop from one hectare was also recorded.

Labor cost of different operations per hectare

Table 5 shows the labor cost of the different farm operations. The total labor cost per hectare was ₱74.95.

The cost of preparing the seed bed plots for one hectare of land was ₱2.72, for preparation of the land, ₱37.63; for transplanting, ₱8.89; for irrigating and draining, ₱0.08; for fertilizing, ₱0.08; for weeding, ₱0.57; for driving away birds, ₱0.49; and for harvesting, ₱24.49.

These figures show that the largest item of expense was for the preparation of land which was 36.06 per cent of the total cost of production.

The second largest item of expense was the cost of harvesting and third was transplanting. The cost of harvesting was 23.45 per cent of the total cost of production and of transplanting, 8.51 per cent.

It may be noted that the cost of harvesting was figured on the share basis, valuing one cavan at ₱2.00. Table 4 shows that the total production for 31.0716 hectares was 1902.1 cavans and one-fifth of this amount which was given to the harvesters and threshers was 380.42 cavans. At ₱2.00 per cavan which was the prevailing price in the locality at the time of harvest the total cost of harvesting was ₱760.84. Table 4 also shows that the time required to harvest 31.0716 hectares of the crop was 7407.5 hours. With ₱760.84 as the cost of harvesting and threshing and 7407.5 hours for the work, the harvesters and threshers were actually paid a little more than ₱0.10 per hour. The actual cost of harvesting and threshing per cavan was ₱0.40.

Supplies and land costs

Table 6 shows the supplies and land costs. The land cost was figured on ₱20 per hectare a year, which is the prevailing land rent in the vicinity of Los Baños, Laguna. Although the land was actually used only from the first operation in August, 1932 to February, 1933, a period of 7 months, the enterprise was charged with the annual rental of ₱20 per hectare inasmuch as the land was used solely for lowland rice. No other crop was raised from the time the rice was harvested until the next planting season. During this period of rest, the land was very dry and cracked because it was summer, and no crop can be grown in this season.

Twenty-nine cavans of seed were used for 31.0716 hectares and cost ₱116.00, or ₱3.75 per hectare. The seeds were selected and furnished by the Farm Crops Division. The seed cost was based on ₱4.00 a cavan.

Table 6 also shows the cost of subsistence during the transplanting of the seedlings. In addition to the wages paid the transplanters they were also given lunch and a light merienda in the afternoon after the transplanting. The subsistence cost ₱127.06 for planting 31.0716 hectare or ₱4.09 per hectare.

Fertilizer was applied in a portion of some of the fields as part of other research work. Inasmuch as that field was a part of the land in this study the cost of fertilizer was included. It amounted to ₱1.03 per hectare.

The total supplies and land cost was ₱896.57 for 31.0716 hectares, or ₱28.85 per hectare.

Cost of production

Table 8 shows the general cost of production per hectare and also the cost of producing one cavan of palay. The total cost of production per hectare was ₱104.43, distributed as follows: labor cost, ₱74.95; supplies and land cost, ₱28.85; and implement cost (from table 8), ₱0.63. With an average production of 61.22 cavans per hectare, the cost of producing one cavan of clean palay was ₱1.706.

Table 9 gives the results of computation of cost of production borne by the farmer.

The cost of production per cavan of clean palay borne by the farmer, as shown in table 9, was ₱1.699. The labor cost was ₱74.95. The harvesting and threshing were paid in palay, that is, one-fifth of the total production. The average production being 61.22 cavans per hectare, the harvester and thresher received 12.24 cavans for their labor. The remaining 48.98 cavans were further divided into five parts, one-fifth or 9.8 cavans going to the College as its share. With ₱2.00 as cost of palay, the value of the College share of 9.8 cavans or charge for the use of the land was ₱19.60. The total cost of production, therefore, was ₱104.03 per hectare, or ₱1.699 per cavan.

The College share of 9.8 cavans per hectare at ₱2.00 per cavan gave the College ₱19.60 for the use of the land, with ₱20 as the land rent per hectare a year the College lost ₱0.40 per hectare, or ₱0.007 per cavan. Adding the farmer's cost of production per cavan which

was ₱1.699 and the College loss of ₱0.007 the final sum is equivalent to the general cost of production of ₱1.706 per cavan as shown in table 8.

Percentage return on the investment

The success of any business or farm enterprise is gauged by the percentage return on the investment.

Table 8 shows that the average production per hectare was 61.22 cavans. At the local selling price of ₱2.00 per cavan the gross income from one hectare was ₱122.44. The cost of production per hectare, as shown in this table was ₱104.43. The net gain therefore, was ₱18.01 per hectare or 17.35 per cent on the total investment.

SUMMARY

1. The preparation of seed bed plots for one hectare of land required a labor cost of ₱2.72
2. It required 476.77 square meters of seed bed plot per hectare of land.
3. The average amount of seeds sown in seed beds for one hectare of land was 23.32 gantas, costing ₱3.73 at ₱4.00 per cavan of seed palay.
4. The preparation of the land was the largest item of expense in the production of lowland rice. The cost was ₱37.63 per hectare or 36.06 per cent of the total cost of production.
5. The labor cost for transplanting the seedlings to a hectare of land was ₱8.89. The subsistence of the planters cost ₱4.09. The total cost of transplanting seedlings to one hectare was ₱12.97 which was 12.42 per cent of the total cost of production.
6. Harvesting and threshing the crop was the second largest item of expense. With one-fifth of the total harvest as the share of the harvester and thresher, it cost ₱24.49 to harvest and thresh the crop from one hectare of land, which was 23.45 per cent of the total cost of production.
7. It took 7,407.50 hours to harvest and thresh the crop from 31.0716 hectares, or 238.40 hours per hectare.
8. With the share of the harvesters and threshers valued at ₱24.49 for one hectare and considering the number of hours, 238.40, required to do this work, the actual labor wage in harvesting and threshing was a little over than ₱0.10 per hour.
9. The actual cost of harvesting and threshing was ₱0.40 per cavan.

10. The total labor cost of the different farm operations was ₱74.05 per hectare.
11. The actual production from 31.0716 hectares was 1902.10 cavans or an average of 61.22 cavans per hectare.
12. The total cost of production per hectare was ₱104.43, distributed as follows: labor cost, ₱74.95; supplies and land cost, ₱28.85; and implement cost, ₱0.63.
13. The cost of producing one cavan of palay considering the land as farmed by an owner was ₱1.706.
14. The net income per hectare was ₱18.01.
15. The percentage return on the investment was 17.25 per cent.
16. It cost the farmer ₱1.699 to produce one cavan; at ₱2.00 a cavan, the current selling price, his gain was ₱0.301.
17. The College received for the use of the land 9.8 cavans per hectare, equivalent to ₱19.60. Considering the land rent as ₱20.00 per hectare per year the College lost ₱0.40 per hectare.

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TABLE 1

Labor requirements in preparing the seed bed plots

LOT NO.	AREA OF THE PLOT	PLOWING		REPAIRING DIKES	HARROWING		LEVELING		TREATING SEEDS	SEEDING	FENCING	AMOUNT OF SEEDS SOWN
		Man labor	Animal labor	Man labor	Man labor	Animal labor	Man labor	Animal labor	Man labor	Man labor	Man labor	
	sq. m.	*hours*	*hours*	*hours*	*hours*	*hours*	*hours*	*hours*	*hours*	*hours*	*hours*	*gantas*
1	425.50	4.5	4.5	2.0	5.0	5.0	0.5	0.5	1.0	0.5	4.0	23.0
2	659.25	5.0	5.0	3.5	3.0	3.0	0.75	0.75	1.5	0.5	3.5	27.0
3	541.65	5.0	5.0	2.0	5.0	5.0	1.00	1.00	1.5	0.75	3.0	27.0
4	427.50	5.5	5.5	1.5	6.5	6.5	1.00	1.00	1.0	1.0	2.0	25.0
5	1564.49	7.0	7.0	4.0	8.0	8.0	2.00	2.00	2.0	1.5	5.0	50.0
6	695.91	8.0	8.0	—	5.0	5.0	3.00	3.00	2.0	2.0	4.0	37.5
7	577.20	6.0	6.0	3.5	13.5	13.5	6.00	6.00	1.5	1.25	5.0	30.5
8	1148.70	15.5	15.5	1.5	7.5	7.5	1.50	1.50	2.5	2.5	6.0	62.5
9	1129.70	10.5	10.5	1.0	7.0	7.0	1.50	1.50	2.0	1.5	4.0	50.0
10	840.00	6.0	6.0	1.0	8.5	8.5	1.50	1.50	2.0	1.5	3.5	30.0
11	1155.94	12.5	12.5	2.0	13.0	13.0	3.25	3.25	2.5	3.25	—	60.0
12	1035.00	4.0	4.0	1.0	3.5	3.5	1.00	1.00	1.5	1.5	3.0	43.0
13	474.02	7.0	7.0	1.5	4.0	4.0	1.50	1.50	1.0	1.0	4.0	30.0
14	401.80	5.75	5.75	1.0	10.0	10.0	2.50	2.50	2.0	1.17	4.0	25.0
15	1065.25	9.5	9.5	1.5	15.0	15.0	3.00	3.00	1.5	2.0	5.5	47.5
16	513.00	5.5	5.5	1.5	7.5	7.5	1.00	1.00	1.0	1.0	3.0	27.0
17	867.04	16.0	16.0	4.0	12.0	12.0	4.00	4.00	1.5	2.5	6.0	50.0
18	414.75	4.0	4.0	1.5	6.0	6.0	1.00	1.00	1.0	0.5	3.0	25.0
19	254.52	4.5	4.5	1.0	4.5	4.5	2.00	2.00	1.0	0.75	4.0	25.0
20	622.80	5.5	5.5	1.5	8.0	8.0	2.00	2.00	1.5	2.0	4.0	30.0
	14813.92	147.25	147.25	36.5	152.5	152.5	40.00	40.00	31.5	28.67	76.5	725.0

TABLE 2

Labor requirements in preparing the land

LOT NO.	AREA	PLOWING		REPAIRING DIKES	HARROWING		CLEANING DIKES
		Man labor	Animal labor	Man labor	Man labor	Animal labor	Man labor
	Ha.	*hours*	*hours*	*hours*	*hours*	*hours*	*hours*
1	1.0804	70.5	70.5	14	82	82	8
2	0.9412	115.0	115.0	24	102	102	8
3	0.8598	93.0	93.0	22	61	61	15
4	1.9426	214.0	214.0	124	186	186	7
5	1.2596	68.5	68.5	22	72	72	8
6	1.6782	131.0	131.0	32	141	141	9
7	2.1966	81.0	81.0	74	253	253	35
8	0.8822	144.0	144.0	72	102	102	15
9	1.4000	158.5	158.5	24	197	197	16
10	3.0904	241.0	241.0	9	368	368	12
11	2.8080	248.0	248.0	12	316	316	12
12	1.3464	137.0	137.0	25	91	91	6
13	1.1708	58.0	58.0	6	85	85	7
14	1.4920	134.0	134.0	8	146	146	8
15	1.1680	116.0	116.0	36	100	100	14
16	2.9730	216.0	216.0	14	182	182	—
17	0.9376	64.0	64.0	9	130	130	8.5
18	1.9272	208.0	208.0	24	104	104	8
19	1.6384	98.0	98.0	56	97	97	8
20	0.2792	16.0	16.0	1	23	23	3
	31.0716	2611.5	2611.5	608	2838	2838	207.5

TABLE 3

Cost of transplanting rice seedlings

LOT NO.	AREA	PULLING UP AND BUNDLING		TOPPING		TRANSPORTING SEEDLINGS			TRANSPLANTING				SUBSIST-ENCE COST
									Distributing		Planting		
		Man labor	Labor cost	Man labor	Labor cost	Man labor	Animal labor	Total man and animal labor cost	Man labor	Labor cost	Man labor	Wage cost	
	Ha.	*hours*	*pesos*	*hours*	*pesos*	*hours*	*hours*	*pesos*	*hours*	*pesos*	*hours*	*pesos*	*pesos*
1	1.0804	16	3.07	2	0.20	7	—	0.70	16	0.80	64	3.84	2.55
2	0.9412	15	4.32	2.5	0.25	6	—	0.60	16	0.80	48	2.88	3.00
3	0.8598	14	4.90	5	0.50	6	—	0.60	14	0.70	49	2.94	4.90
4	1.9426	32	6.80	7	0.70	30	—	3.00	45	2.25	135	8.10	14.50
5	1.2596	40	4.80	3	0.30	4	4	0.80	36	1.80	72	4.23	4.90
6	1.6782	16	4.00	6	0.60	7	—	0.70	8	0.40	32	1.92	1.50
7	2.1966	32	8.28	9	0.90	9	9	1.80	32	1.60	160	9.60	6.35
8	0.8822	25	4.00	7	0.70	4	4	0.80	42	2.10	119	7.14	8.80
9	1.4000	12	4.40	5	0.50	4	4	0.80	35	1.75	119	7.14	7.45
10	3.0904	27	8.00	5	0.50	6	6	1.20	32	1.60	144	8.64	6.13
11	2.8080	45	6.24	8	0.80	10	10	2.00	48	2.40	256	15.36	9.10
12	1.3464	8	6.24	2	0.20	8	—	0.80	8	0.40	80	4.80	4.70
13	1.1708	16	4.24	6	0.60	3	3	0.60	12	0.60	60	3.60	6.17
14	1.4920	28	2.32	4.5	0.45	6	6	1.20	27.5	1.38	82.5	4.95	7.36
15	1.1680	30	3.88	7	0.70	8	—	0.80	8	0.40	64	3.84	4.25
16	2.9730	40	10.84	8	0.80	7	7	1.40	49	2.45	189	11.34	17.25
17	0.9376	16	3.84	5	0.50	4	—	0.40	16	0.80	56	3.36	3.40
18	1.9272	40	5.44	7	0.70	8	—	0.80	16	0.80	117	7.02	11.20
19	1.6384	20	4.48	3	0.30	8	—	0.80	16	0.80	104	6.24	3.55
20	0.2792	1	0.64	0.5	0.05	0.5	0.5	0.10	—	—	16	0.96	—
	31.0716	482	104.63	102.5	10.25	145.5	53.5	19.90	476.5	23.83	1966.5	117.99	127.06

TABLE 4

Data on harvesting and threshing

LOT NO.	AREA	HARVESTERS AND THRESHERS	LABOR	PRODUCTION [a]		SHARE OF HARVESTERS AND THRESHERS (1/5 OF TOTAL HARVEST)	COST OF SHARE AT ₱2 PER CAVAN
				Actual	Per hectare		
	Ha.	*number*	*hour*	*cavans*	*cavans*	*cavans*	*pesos*
1	1.0804	35	115	104.60	96.82	20.92	41.84
2	0.9412	61	259	56.25	59.76	11.25	22.50
3	0.8598	74	456	76.85	89.38	15.37	30.74
4	1.9426	213	682	173.25	89.38	34.65	69.30
5	1.2596	55	260	65.65	52.15	13.13	26.26
6	1.6782	104	257.5	55.15	52.11	11.03	22.06
7	2.1966	104	569	135.85	80.94	27.17	54.34
8	0.8822	100	265	119.75	35.57	23.95	47.90
9	1.4000	85	455	63.00	45.43	12.72	25.44
10	3.0904	161	805	151.05	48.97	30.21	60.42
11	2.8080	149	381	183.60	63.39	36.72	73.44
12	1.3464	84	676	103.45	79.07	20.69	41.38
13	1.1798	61	212	90.05	76.33	18.01	36.02
14	1.4920	72	283	96.55	64.71	19.31	38.62
15	1.1680	115	287.5	73.85	63.22	14.77	29.54
16	2.9730	101	425.5	133.45	44.89	26.69	53.38
17	0.9376	45	155	30.35	32.37	6.07	12.14
18	1.9272	59	256.5	70.90	36.79	14.18	28.36
19	1.6384	63	502.5	101.95	62.23	20.38	40.78
20	0.2792	18	105	15.95	57.19	3.19	6.38
Total	31.0716	1759	7407.5	1902.10	1232.67	380.42	760.84

[a] Average production per hectare was 61.22 cavans.

TABLE 5

Cost of different farm operations for 31.0716 hectares

	KIND OF LABOR	TIME	WAGE PER HOUR	LABOR COST	TIME PER HECTARE	COMPUTED LABOR COST PER HECTARE
Preparation of seed bed:		*hours*	*pesos*	*pesos*	*hours*	*pesos*
Plowing	Man	147.25	0.10	14.73	4.74	0.47
	Animal	147.25	0.10	14.73	4.74	0.47
Repairing dikes	Man	36.5	0.10	3.65	1.11	0.11
Harrowing	Man	152.5	0.10	15.25	4.91	0.49
	Animal	152.5	0.10	15.25	4.91	0.49
Leveling	Man	40.0	0.10	4.00	1.29	0.13
	Animal	40.0	0.10	4.00	1.29	0.13
Treating seeds	Man	31.5	0.10	3.15	1.01	0.10
Seeding	Man	28.67	0.10	2.87	0.92	0.09
Fencing	Man	75.5	0.10	7.55	2.43	0.24
Preparation of land:						
Plowing	Man	2611.5	0.10	261.15	84.04	8.24
	Animal	2611.5	0.10	261.15	84.04	8.24
Repairing dikes	Man	608.0	0.10	60.80	19.57	1.97
Harrowing	Man	2838.0	0.10	283.80	91.33	9.13
	Animal	2838.0	0.10	283.80	91.33	9.13
Cleaning dikes	Man	286.0	0.10	28.60	9.20	0.92
Transplanting:						
Pulling up and bundling seedlings	Man	482.0	0.22	106.04	15.51	3.41
Topping seedlings	Man	102.5	0.10	10.25	3.29	0.33
Transporting bundled seedlings	Man	145.5	0.10	14.55	4.68	0.43
	Animal	53.5	0.10	5.35	1.72	0.17
Distributing bundled seedlings	Man	476.5	0.05	23.83	15.34	0.75
Planting	Man	1966.5	0.06	117.99	63.29	3.80
Draining and irrigating	Man	26.0	0.10	2.60	0.83	0.08
Fertilizing	Man	26.0	0.10	2.60	0.83	0.08
Weeding	Man	177.5	0.10	17.75	5.71	0.57
Driving away birds	Man	504.0	0.03	15.12	16.22	0.49
Harvesting and threshing	Man	7407.5		760.84	238.40	24.49
Total						74.95

TABLE 7

Depreciation of implements and interest on the investment for 31.0716 hectares

IMPLEMENTS	COST	LIFE IN YEARS	MAXIMUM NUMBER OF DAYS (9 HR.) USED IN ONE YEAR	RATE OF INTEREST PER YEAR	NUMBER OF HOURS ACTUALLY USED	DEPRECIATION	INTEREST	TOTAL DEPRECIATION AND INTEREST	TOTAL DEPRECIATION AND INTEREST PER HA.
	pesos			*per cent*		*pesos*	*pesos*	*pesos*	*pesos*
Native plow	17.00	4	100	10	2708.25	13.2549	1.4603	14.7152	0.4736
Lowland harrow, or suyod	9.00	8	100	10	2989.50	3.7369	0.8072	3.5441	0.1141
Harrow, or calmot	5.00	3	100	10	41.00	0.0759	0.0062	0.0821	0.0026
Winnowing baskets	0.50	1	100	10	28.666	0.0159	0.0004	0.0163	0.0005
Sacks, 60	0.25	1	200	10	96.00	0.7980	0.0438	0.8418	0.0271
Sled, or paragus	7.00	3	90	10	53.00	0.1527	0.0113	0.1640	0.0053
Native bolo	1.75	2	150	10	343.80	0.2228	0.0183	0.2411	0.0078
Total								19.6046 or 19.60	0.6310 or 0.63

A STUDY OF THE RESULTS OF THE SECOND PHILIPPINE EGG LAYING CONTEST [1]

F. M. FRONDA
Of the Department of Animal Husbandry

The Second Philippine Egg Laying Contest was started in the College of Agriculture on September 1, 1931. The contest was run for a full year, 366 days, and was closed on August 31, 1932. The regulations under which this contest was conducted were essentially the same as those that governed the First Philippine Egg Laying Contest. [2]

Entries. Eight pens were entered in this contest. The breeds represented, together with the names of the owners, were as follows:

1. Los Baños Cantonese, Ordoveza Poultry Farm, Bay, Laguna.
2. S. C. White Leghorn, Parañaque Poultry Farm, Parañaque, Rizal.
3. Nagoya, Nagoya Breeding Farm, 20 San Juan Addition, Rizal.
4. Mikawa, Nagoya Breeding Farm, 20 San Juan Addition, Rizal.
5. Los Baños Cantonese, College of Agriculture, Los Baños, Laguna.
6. Nagoya, College of Agriculture, Los Baños, Laguna.
7. S. C. White Leghorn, College of Agriculture, Los Baños, Laguna.
8. S. C. Rhode Island Red, Hacienda Carmelita, Inc., San Jose del Monte, Bulacan.

Ration used. The ration consisted of equal parts of grain and mash. The grain was composed of equal parts of corn and palay and the mash was made up of six parts, by weight, of rice bran, one part of corn meal, one part of copra meal and two parts of shrimp meal. It will be noted that the composition of the mash used in this contest differed from that of the First Philippine Egg Laying Contest.[2] This change was made in accordance with the suggestion

[1] Experiment Station contribution No. 892. Received for publication May 9, 1933.

[2] FRONDA, F. M. 1932. A study of the results of the First Philippine Egg Laying Contest. The Philippine Agriculturist 20: 596–603.

[2] *loc. cit.*

received from study of the results obtained in an experiment carried in this College on the influence of various mashes on egg production. [3]

Although minor changes had to be made in the composition of the feed in all pens during certain parts of the year, these changes were made gradually. At current prices, the cost of the grain mixture used was ₱0.0481 a kilogram and that of the mash, ₱0.0625 a kilogram. The average cost of the ration was therefore ₱5.53 a hundred kilograms.

Care and management. Upon arrival in the College, the birds were placed in temporary quarters and given their contest numbers. The grain feed was given to them morning and afternoon and the mash was given dry in mash hoppers that were kept open at all times. The same system of feeding was followed after the birds were transferred to the contest houses in the morning of September 1, 1931. All feeds consumed were carefully recorded. The birds were weighed at the end of every month, and the weights recorded. Each entry was penned in one contest house, 1.8 meters by 2.4 meters, provided with two grassy yards which were rotated at regular intervals depending upon the supply of green feed in the yard.

Egg production. Careful records were made of egg production. All eggs produced were weighed in the afternoon of the day they were laid. Only the trapnested eggs of the ten highest birds in the pen were included in the official pen production. The unidentified eggs, "out eggs", were not included in the computation of the official records of each pen, but these eggs were included in the determination of the returns from the sale of eggs, after these had been equally distributed on the basis of ten birds.

All eggs produced in the contest were sold at current table egg prices, based upon the following classification and with the corresponding prices per dozen:

C.A. Primes (60 grams or over each)	₱0.84
C.A. Specials (55 to 59 grams each)	0.72
C.A. Extras (50 to 54 grams each)	0.60
C.A. Standards (45 to 49 grams each)	0.48
C.A. Undergrades (44 grams or less each) ...	0.36

RESULTS

The birds entered. All the birds that were entered in this contest were apparently in excellent condition at the beginning of the contest. The average weights of the different entries at the

[3] FRONDA, F. M. 1932. Comparative studies of the values of different mash mixtures for egg production. The Philippine Agriculturist 21: 96–105.

beginning and at the end of the contest are given in table 1, by reference to which, it may be seen that, in general, the birds all gained in weight. The probable exception to this statement is that of S. C. White Leghorn, Entry No. 7, which recorded a decrease of 0.20 kilograms. This decrease may have been due to the heavy egg production of this entry, as is noted elsewhere in this report. Entries Nos. 1, 2, 6, 7, and 8 reached their maximum weights in February, or six months after the contest was started, the weights being 1.61, 1.33, 2.03, 1.64 and 2.15 kilograms for Entries Nos. 1, 2, 6, 7, and 8, respectively. Entries Nos. 4 and 5 reached their maximum weights of 1.99 and 1.89 kilograms each, respectively, in March, while Entry No. 3 did not attain its maximum weight of 2.14 kilograms until May.

TABLE 1

Showing the weights of the birds entered in the contest, 1931-32

ENTRY NO.	BREED	AVERAGE WEIGHT		
		September 1931	August 1932	Year
		kgm.	*kgm.*	*kgm.*
1	Los Baños Cantonese	1.31	1.44	1.46
2	S. S. White Leghorn	1.09	1.16	1.20
3	Nagoya	1.66	1.87	1.90
4	Mikawa	1.78	1.86	1.85
5	Los Baños Cantonese	1.36	1.50	1.59
6	Nagoya	1.62	1.91	1.88
7	S. C. White Leghorn	1.44	1.24	1.45
8	S. C. Rhode Island Red	1.98	2.05	2.06

The average weights recorded in the last column of table 1 represent the average of all the monthly weights of the different entries recorded during the year. According to these figures, the average weights of the different breeds represented in the contest were as follows: S. C. White Leghorn, 1.35 kilograms; Los Baños Cantonese, 1.53 kilograms; Mikawa, 1.85 kilograms; Nagoya, 1.89 kilograms; and S. C. Rhode Island Red, 2.06 kilograms.

Egg production. Fourteen, or 17.5 per cent of the eighty birds entered in this contest, made a record of over 200 eggs each. The records of these birds ranged from 201 to 257 eggs each in 366 days. The highest record of individual egg production was made by a S. C. White Leghorn pullet, No. 83, Entry No. 7, with 257 eggs to her credit. This is 15 eggs better than the highest individual record made last year.[2] Two pullets, S. C. White Leghorn No. 87, Entry

[2] *loc. cit.*

No. 7, and S. C. Rhode Island Red No. 101, Entry No. 8, tied for the second place as each bird laid 254 eggs. Of the fourteen birds in this group, eight were S. C. White Leghorn pullets with records varying from 203 to 257 eggs each, three were Mikawa pullets with 201 to 216 eggs each, two were Los Baños Cantonese pullets with production of 201 and 203 eggs each, and one, S. C. Rhode Island Red pullet with 254 eggs to her credit.

TABLE 2

Showing the egg production of each entry

ENTRY NO.	BREED	NUMBER OF EGGS PRODUCED		
		Recorded	"Outs"	Total
1	Los Baños Cantonese	1650	92	1742
2	S. C. White Leghorn	1500	60	1560
3	Nagoya	1696	148	1844
4	Mikawa	1734	141	1875
5	Los Baños Cantonese	1543	138	1681
6	Nagoya	1557	183	1740
7	S. C. White Leghorn	2085	129	2214
8	S. C. Rhode Island Red	1777	178	1955
	Total	13542	1069	14611

As may be seen in table 2, a total of 13,542 eggs were recorded in 366 days from the 80 birds entered in the contest. This represents an average "official" production of 169.2 eggs each or 46.2 per cent. The total production of each pen ranged from 1,500 eggs to 2,085 eggs, 41.0 to 57.0 per cent. Entry No. 7, S. C. White Leghorn, produced a total of 2,085 eggs or an average of 208.5 eggs each. Entry No. 8, S. C. Rhode Island Red, produced 1,777 eggs, 177.7 eggs each; this pen occupies the second place. The Mikawa pen, Entry No. 4, occupies the third place with 1,734 eggs, 47.4 per cent, to its credit.

This egg production does not include those eggs that were not identified, or the "out eggs". There were 1,069 of these eggs, which, together with the recorded eggs, totalled 14,611 eggs. The "out eggs" represented, therefore, 7.3 per cent of the total number of eggs produced during the year. The "out eggs", however, did not change the ranking of the first three best entries, Entry No. 7, S. C. White Leghorn, the first, Entry No. 8, S. C. Rhode Island Red, the second, and Entry No. 4, Mikawa, the third. The average production per bird, including the "out eggs" becomes 182.6 eggs.

The distribution of egg production of the different breeds in the contest is presented in table 3. By referring to this table it will

be seen that the distribution of egg production was normal in all breeds. The trend of egg production followed is similar to that of the last year's pens.

TABLE 3

Showing the distribution of egg production of the different breeds in the contest

MONTH	BREEDS					ALL BREEDS
	S. C. White Leghorn	Los Baños Cantonese	Nagoya	Mikawa	S. C. Rhode Island Red	
September	49.8	48.8	51.8	36.3	27.3	42.8
October	54.6	47.4	40.0	45.2	49.3	47.3
November	55.3	42.5	37.6	40.7	50.3	45.3
December	59.7	38.8	48.7	61.0	63.8	54.4
January	63.8	48.7	66.1	62.6	68.4	61.3
February	66.2	55.2	54.4	65.5	73.8	63.0
March	61.4	54.2	58.6	61.3	56.1	58.3
April	48.8	47.6	52.0	55.3	48.3	50.4
May	45.8	50.8	48.0	57.1	53.5	51.0
June	31.3	43.5	45.5	47.0	46.0	42.7
July	43.7	40.9	40.1	45.8	53.2	44.7
August	40.6	40.4	46.3	35.8	50.0	42.6
Average	51.7	46.6	49.1	51.1	53.3	50.3

Feed consumption. A total of 1,333.4 kilograms of grain and 1,390.2 kilograms of mash were consumed by the birds in all pens during the entire contest year. These amounts do not include feed consumed by the alternates. This gives an average consumption of 16.67 kilograms of grain and 17.38 kilograms of mash, totalling 34.05 kilograms for each pen. The feed consumption of the different pens and the cost of these feeds are given in table 4.

TABLE 4

Showing the amount and cost of feeds consumed by each pen, computed on the basis of ten birds

ENTRY NO.	BREED	FEED CONSUMED			COST OF FEED [a]
		Grain	Mash	Total	
		kgm.	*kgm.*	*kgm.*	
1	Los Baños Cantonese	159.9	147.9	307.8	₱16.93
2	S. C. White Leghorn	156.8	156.3	313.1	17.31
3	Nagoya	159.2	180.4	339.6	18.93
4	Mikawa	172.9	183.3	356.2	19.77
5	Los Baños Cantonese	142.4	154.7	297.1	16.52
6	Nagoya	163.4	176.6	340.0	18.90
7	S. C. White Leghorn	184.0	181.5	365.5	20.19
8	S. C. Rhode Island Red ..	194.8	209.5	404.3	22.46
	Average	16.67	17.38	34.05	₱1.89

[a] Grain @ ₱4.81 a hundred kilograms.
Mash @ ₱6.25 a hundred kilograms.

By reference to table 4 it may be seen that the feed consumptions of the two Los Baños Cantonese entries, Entries Nos. 1 and 5, were fairly uniform. The same is true of the two Nagoya pens, Entries Nos. 3 and 6. There was a wide difference between the feed consumption of the two S. C. White Leghorn entries, Entries Nos. 2 and 7. This was apparently due to the great difference in the number of eggs produced by these two pens, as is pointed out in the first part of this paper.

When computed on the basis of feed consumption per bird according to breeds represented, it was observed that the S. C. Rhode Island Red fowls consumed the most, 40.43 kilograms of feed each. The Mikawa fowls consumed 35.65 kilograms each, the Nagoyas, 33.98, while the S. C. White Leghorns consumed 33.93 kilograms of feed each. As in the previous year, the Los Baños Cantonese fowls consumed the smallest amount of feed, only 30.04 kilograms for each bird.

Table 4 also gives the cost of the feeds consumed by each pen. By reference to this table, it will be seen that the cost of feeds consumed by each pen during the year varied from ₱16.52 in Entry No. 5, Los Baños Cantonese to ₱22.46 in Entry No. 8, S. C. Rhode Island Red. According to breeds represented in the contest, the cost of the feeds consumed were as follows: Los Baños Cantonese, ₱16.73; S. C. White Leghorn, ₱18.75; Nagoya, ₱17.92; Mikawa, ₱19.77; and S. C. Rhode Island Red ₱22.46.

Returns from the sale of eggs. In computing the income from the sale of eggs, the total pen production, including the "out eggs", that is, those that were laid outside the trapnest, distributed on the basis of ten birds was used. The total number of eggs thus produced by each pen (see also table 2), the percentage of eggs in each of the grades used in the contest, with the total income derived from these are given in table 5.

By reference to table 5, it may be seen that the S. C. Rhode Island Reds, Entry No. 8, had the largest return from the sale of eggs, being ₱112.17. This pen was only second in the number of eggs produced, but the eggs produced were the largest of all the entries. Entry No. 7, S. C. White Leghorns, produced the largest number of eggs, but the eggs were smaller than those of the S. C. Rhode Island Reds. This pen brought in only ₱93.26 from the sale of eggs.

TABLE 5

Showing the total pen production of the different entries and the distribution of the size of eggs

ENTRY NO.	BREED	TOTAL EGGS LAID [a]	SIZE DISTRIBUTION [b]					VALUE
			Undergrade	Standard	Extra	Special	Prime	
			per cent	*per cent*	*per cent*	*per cent*	*per cent*	*pesos*
1	Los Baños Cantonese ..	1742	82.4	15.3	2.1	0.1	0.1	56.07
2	S. C. White Leghorn ..	1560	38.3	37.9	21.0	2.8	—	60.56
3	Nagoya	1844	25.8	32.3	31.3	7.5	3.0	79.12
4	Mikawa	1875	29.1	35.4	24.6	7.9	3.0	78.82
5	Los Baños Cantonese .	1681	54.2	37.0	8.4	0.5	—	60.25
6	Nagoya	1740	12.5	50.4	27.7	4.0	5.4	76.38
7	S. C. White Leghorn .	2214	20.9	42.8	30.7	5.3	0.3	93.26
8	S. C. Rhode Island Red	1955	0.8	6.5	29.8	44.1	18.8	112.17
	Average per pen	1826	33.0	32.2	22.0	9.0	3.8	77.08

[a] Including "out eggs".

[b] C. A. Undergrades, 44 grams or less each.
C. A. Standard, 45 to 49 grams each.
C. A. Extra, 50 to 54 grams each.
C. A. Special, 55 to 59 grams each.
C. A. Prime, 60 grams or more each.

According to the breeds represented, the total incomes derived from the sale of market eggs were as follows: Los Baños Cantonese, ₱58.16; Nagoya, ₱77.75; Mikawa, ₱78.82; S. C. White Leghorn, ₱81.91; and S. C. Rhode Island Red, ₱112.17. The average returns derived from each bird in the contest was ₱7.71.

Returns from the sale of eggs over the cost of feeds. Table 6 gives the cost of feeds consumed and the value of the eggs produced during the year. By deducting the cost of feeds consumed from the value of eggs produced, the returns over the cost of feeds was obtained.

By reference to table 6, it may be seen that the returns from the sale of eggs over the cost of feeds varied from ₱89.71, Entry No. 8, S. C. Rhode Island Red, to ₱39.14, Entry No. 1, Los Baños Cantonese. According to breeds, the returns were as follows: Los Baños Cantonese, ₱41.44; S. C. White Leghorn, ₱58.16; Nagoya, ₱58.84; Mikawa, ₱59.05; and S. C. Rhode Island Red, ₱89.71. In this connection, the large eggs produced by the S. C. Rhode Island Reds proved to be a decided advantage to this breed.

TABLE 6

Showing the cost of feeds consumed, the value of eggs produced and the returns above the cost of feeds

ENTRY NO.	BREED	COST OF FEED	VALUE OF EGGS	RETURNS ABOVE THE COST OF FEEDS
		pesos	*pesos*	*pesos*
1	Los Baños Cantonese	16.93	56.07	39.14
2	S. C. White Leghorn	17.31	60.56	43.25
3	Nagoya	18.93	79.12	60.19
4	Mikawa	19.77	78.82	59.05
5	Los Baños Cantonese	16.52	60.25	43.73
6	Nagoya	18.90	76.38	57.48
7	S. C. White Leghorn	20.19	93.26	73.07
8	S. C. Rhode Island Red	22.46	112.17	89.71

Cost of producing one dozen eggs. The cost of producing one dozen eggs, based upon the amount of feeds consumed by each of the pens entered in the contest is given in table 7.

TABLE 7

Showing the cost of producing one dozen eggs

ENTRY NO.	BREED	FEED TO PRODUCE 1 DOZEN EGGS	FEED COST TO PRODUCE 1 DOZEN EGGS	TOTAL COST [a] TO PRODUCE 1 DOZEN EGGS
		kgm.	*centavos*	*centavos*
1	Los Baños Cantonese	2.12	11.7	19.4
2	S. C. White Leghorn	2.41	13.3	22.1
3	Nagoya	2.21	12.2	20.2
4	Mikawa	2.28	12.6	20.9
5	Los Baños Cantonese ...	2.12	11.7	19.4
6	Nagoya	2.34	12.9	21.4
7	S. C. White Leghorn	1.98	10.9	18.1
8	S. C. Rhode Island Red ..	2.48	13.7	22.7

[a] If feed represents 60.3 per cent of the total cost of production.

By reference to table 7 it may be seen that the amount of feeds required to produce a dozen eggs varied from 1.98 kilograms (Entry No. 7, S. C. White Leghorn) to 2.48 kilograms (Entry No. 8, S. C. Rhode Island Red). The cost of feeds varied from 10.9 centavos to 13.7 centavos a dozen. If the cost of feeds represents 60.3 per cent of the total cost of production,[4] the total cost of production varied from only 18.1 centavos to 22.7 centavos a dozen eggs. According

[4] FRONDA, F. M., AND PEDRO S. PAJE. 1930. Factors in the cost of egg production. The Philippine Agriculturist 19: 337–353. *Charts 1–4.*

to breeds represented, the costs of producing a dozen eggs were as follows: Los Baños Cantonese, 19.4 centavos; S. C. White Leghorn, 20.1 centavos; Nagoya, 20.8 centavos; Mikawa, 20.9 centavos and S. C. Rhode Island Red, 22.7 centavos.

Mortality. Of the total of 104 birds in the contest, 8 died during the year, which represents a total mortality of only 7.7 per cent. No mortality was recorded in Entries No. 3, Nagoya, No. 5, Los Baños Cantonese and No. 8, S. C. Rhode Island Red. One bird died in each of Entries No. 6, Nagoya and 7, S. C. White Leghorn; and two birds died in each of Entries No. 1, Los Baños Cantonese, No. 2, S. C. White Leghorn, and No. 4, Nagoya. The mortality in the First Philippine Egg Laying Contest was 13.58 per cent.[5]

SUMMARY

1. Eight pens were entered in the Second Philippine Egg Laying Contest. Two of these were Los Baños Cantonese, two were S. C. White Leghorns, two were Nagoyas and one each of Mikawas and of S. C. Rhode Island Reds.

2. All entries gained in weight during the year.

3. Fourteen or 17.5 per cent of the eighty birds entered in this contest made a record of over 200 eggs each.

4. The highest record of individual egg production was made by a S. C. White Leghorn pullet with 257 eggs to her credit.

5. The average "official" production was 169.2 eggs each bird; including the "out eggs", the average was 182.6 eggs.

6. The average feed consumption per pen was 34.05 kilograms. The S. C. Rhode Island Reds consumed the most feed, 40.43 kilograms to each bird and the Los Baños Cantonese the least, 30.04 kilograms to each.

7. The average returns from the sale of eggs was ₱7.71 each bird. The S. C. Rhode Island Red entry had the highest return, ₱112.17.

8. The S. C. Rhode Island Red entry produced the largest eggs. This entry had also the largest return over the cost of feeds from the sale of eggs.

9. The cost of producing a dozen eggs varied from 18.1 to 22.7 centavos. The Los Baños Cantonese breed produced the most economical eggs, the S. C. Rhode Island Red, the most expensive.

10. The mortality in all pens during the year was only 7.7 per cent.

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[5] *loc. cit.*

ABSTRACT [1]

Sweet potato, *Ipomoea batatas* Linn. vs. *Calopogonium mucoconoides* Desv., a legume, as pasture crops for growing pigs. ALEJANDRO V. SORIANO. (*Thesis presented for graduation, 1931, from the College of Agriculture, No. 350; Experiment Station contribution, No. 893*)—The object of this work was to compare the efficiency of *Calopogonium* with sweet potato, as a forage for growing pigs on a ration mixture consisting of 20 parts corn, 60 parts rice bran, 17 parts copra meal, and 3 parts shrimps for weanlings and on a ration mixture made up of 20 parts corn, 60 parts rice bran and 20 parts copra meal for shotes.

Thirty-five 24-kgm. Berkjala pigs were put on a 70-day feeding test; they were divided into five lots of 7 pigs each. The pigs in lot I were given a full ration in dry lot; those in lot II were given a limited ration with *Calopogonium* soilage; lot IV was full fed with access to sweet potato pasture; and lot V was full fed with access to *Calopogonium* pasture.

The pastures of *Calopogonium* and sweet potato were of the same age.

The following results were obtained: From the point of view of rate of gains made, lot IV was first with an average daily gain per pig of .22 kgm.; lot I, second with .19 kgm.; lot II, third with .18 kgm.; lots III and V, last with .15 kgm. each. Basing calculations on feed required to make a given unit of gain, lot IV was again first with 2.1 kgm. feed consumed to make a kilogram gain; lot II, second with 2.7 kgm.; lot III, third with 3.1 kgm.; lot V, fourth with 3.2 kgm.; and lot I, fifth with 3.9 kgm. The camote soilage of 315 kgm. given lot II had a feed value equivalent of 103 kgm.; or 3 kgm. camote soilage is equivalent to 1 kgm. of the ration mixture used.

Basing conclusion on the comparative results obtained from lots I and IV, a hectare of camote pasture had a feed value equivalent of 1,146 kgm. and at the price of the feed mixture used at the time it was worth ₱86.17. The principal reason the *Calopogonium* lots gave the poorest results was that the pigs found the *Calopogonium* unpalatable. The fact that lot III was given the same amount of ration as lot II, similarly with lots IV and V, and that the pigs in

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[1] Abstract presented as part of work required in English 3a, College of Agriculture.

the *Calopogonium* lots hardly made use of their *Calopogonium* forage caused the pigs in these lots (III and V) to be underfed. In other words the *Calopogonium* lots did not do as well as the camote lots, not because of any ill effects from eating *Calopogonium* but because they did not get the full feeding they needed. For this same reason it was impossible to calculate the feed value equivalent of the *Calopogonium* forage. The experiment did show, however, that *Calopogonium* is not relished by pigs.

The author conducted another 70-day feeding trial with 28 38-kgm. Berkjala pigs divided into four lots. Lot I on sweet potato pasture was given full ration; lot II on sweet potato pasture, one-half ration; lot III on *Calopogonium* pasture, full ration; and lot IV on *Calopogonium* pasture, one-half ration.

The trial gave the following results: basing calculations on rate of gains made, lot I gave the most satisfactory result with an average daily gain per pig of .29 kgm.; lot III, second, with .21 kgm.; lot II third, with .18 kgm.; and lot IV fourth, with .15 kgm. From the results from the amount of feed necessary to make a given gain, lot II was first with 3.3 kgm. feed for every kilogram gain; lot IV second, with 4.0 kgm.; lot I third, with 4.1 kgm.; and lot III fourth, with 5.6 kgm. feed.

The outstanding result obtained is the marked superiority of sweet potato over *Calopogonium* as pasture for hogs, full fed or on limited rations. Another result of importance is that where rapid growth and development is the object sought, as for breeding stock, full feeding with access to a good pasture like sweet potato is a better practice than limiting the ration.

—*Abstract by A. D. Pablo*

CURRENT NOTES

One hundred years ago, consumption of sugar in the United States totalled 61,000 long tons, at the rate of only 9.96 lbs. per head. Fifty years ago consumption aggregated 1,061,000 tons, or 45.09 lbs. per head of population. The figures for 1932 (preliminary) showed a per capita consumption of 101 3/4 lbs., as against 108.4 lbs. in 1931.

The Australian Sugar Journal, March 9, 1933.

In some cases prices for this fibre (Manila hemp) fell to the lowest level on record. Unfortunately for the producing side, Manila fibre is a most vulnerable target for the slings and arrows of

adversity, being one of the worst sufferers from such a world-wide depression as we are now up against in the shipbuilding trade in all its sections, new craft, repairs, renewals.

Tropical Life, February, 1933.

Doctors and hospitals are rapidly becoming used to prescribing honey in the diet of invalids and particularly those suffering from diabetes. Some conclusive evidence is being brought out to the effect that many invalids who cannot use sugar and similar sweets in their diets, may use honey more or less freely without any of the serious effects which ordinarily develop from some other sweets. Quite a number of people suffering from diabetes have found that honey may be used, and cases have been reported showing that honey may be used quite freely without any ill effect. It is also known that bacteria which cause some of our common diseases, such as typhoid and dysentery cannot live in honey for more than a few hours. We may therefore expect to find, when proper investigations have been made, that honey has strong medicinal qualities, and that it will be deemed as necessary in the diet of people as many of the products now used for the healthful development of the human body.

The Journal of the Jamaica Agricultural Society, January, 1933.

The education of farmers' daughters who are to remain on the land is of quite as much importance as that of the sons....

Classes in butter making and poultry keeping are organized throughout the counties at which instructions largely of a practical nature are given by the County Instructress. Lectures on these subjects are also given at schools in rural areas....

The only State school for girls is the Munster Institute. The school is run primarily for the training of girls who are to return to the land, but it is also used to a lesser extent for the training of teachers in butter making and poultry keeping. The normal period of training for girls returning home is two terms each of about 22 weeks duration, and four terms for girls who qualify as teachers.

The Farmers' Gazette (Ireland), February 18, 1933.

In spite of the low prices last year of coconut, the value of production of which was 40 per cent less, resulting in a loss of some ₱30,000,000 to the owners, the planting of coconut did not stop. Over 2,000,000 coconut trees on 12,000 hectares were planted last year.

Commerce and Industry Journal, (Philippines) April, 1932.

Now that regulations governing the retail sale of eggs are in force, it is the duty of all producers to see that retailers are supplied with eggs that will comply with those regulations. The more efficiently the producers do their job, the quicker will be the turnover by the retailer, and the greater the satisfaction of the consumers. This will quickly lead to increased consumption. Every purchaser of eggs from shop, stand, or stall, is entitled to be supplied only with eggs of specified quality and of the weight he or she desires or can afford.

Briefly, the provisions as to quality laid down in the regulations are that:—"No person shall sell any egg unless it is sound and wholesome; on candling the white is translucent and the yolk translucent or but faintly visible. The air cell must not exceed one-quarter of an inch in depth. Chilled eggs must be branded with the word 'chilled,' and the air cell must not be greater than three-eighths of one inch." Eggs must be sold in the following grade weights:—

"Special" must weigh not less than 2 1/4 oz. each.

"Standards" must weigh not less than 2 oz. each.

"Medium" must weigh not less than 1 3/4 oz.

"Small," all eggs less than 1 3/4 oz.

The proprietor of any shop, stand, stall, &c., where eggs are sold is required to keep the various grades of eggs in separate receptacles and to affix to each a placard, on which shall be printed or written the grade of eggs in plain and legible characters plainly visible to customers.

Journal of Agriculture, (Australia) March, 1933.

COLLEGE AND ALUMNI NOTES

Mrs. Harriet Richards formerly of the faculty in the Cebu Branch of the University of the Philippines succeeds Miss Williamson as instructor in English in the Rural High School of this College.

Mr. Zosimo Montemayor B. Agr. '24, B. S. Agr. '28 was a welcome Campus visitor in May. Mr. Montemayor is Principal of Camarines Agricultural High School. Rumor says that he is doing exceptionally good work in this school. He is making it a real farm school. The enrollment is between two and three hundred. Mr. Montemayor has changed the dormitory system with free board and lodging to a living on the farm plan. There is a credit or school exchange system whereby products grown by students are received

and necessities bought. In the 1933 graduating class 37 students had ₱800 coming to them from this exchange. One or more of these students who received the larger shares, bought from one to two hectares of land with their student profit.

On May 1 at six o'clock in the morning in the Catholic Chapel with Father Casey officiating, Miss Victorina Adriatico and Mr. Esteban Collado were united in marriage.

The trees and shrubs gently swaying in the breeze in the morning sunshine were framed as pictures in the windows and doors of the chapel, and within the green palms and white flowers, a white floral wedding bell, and the white canvased aisle all made a perfect setting for the marriage ceremony. The bride in a white satin gown with train and wearing the conventional veil was all a bride is expected to be as she walked up the aisle on the arm of her father to the strains of the Lohengrin wedding march played by Miss Villegas. The groom—and never was there a groom on whose countenance happiness was written with clearer lines—met the bride at the altar. To add the perfect touch, during the ceremony and the mass, many birds in the trees sang their good wishes in their best and gayest morning voices.

A wedding breakfast was served to a large number of friends in Molawin Hall.

Miss Adriatico has been a chief nurse in the College Infirmary since it opened in 1930. Mr. Collado, a B. Agr. '19 and M. S. '22, has been on the Chemistry staff as graduate assistant and instructor since his graduation.

All College friends of the bride and groom and this includes all members of faculty, student body and employees wish them happiness, health and prosperity.

The following excerpt is from *Tropical Life*, (London) March, 1933:

The Philippine Agriculturist for December (1932) (published by the College of Agriculture, Laguna, P. I.) includes two articles. The first one by Mr. Martin S. Celino, plant pathologist, starts by telling us that in January, 1930, a dead coconut leaf miner (*Promecotheca cumingii* Baly) which was pasted by a fungous growth on the under surface of a coconut pinna, was found on one of the trees in the nursery of the College of Agriculture at Los Baños, Laguna, Philippine Islands (Celino, 1930). The fungous growth appeared almost white and chalky and it nearly covered the body of the insect. Microscopic examina-

tion of the powdery mass showed smooth, hyaline, septate mycelium and numerous smooth, small, spherical spores with olive buff contents. This fungous disease of *Promecotheca cumingii* has not been known hitherto in the Philippine Islands.

Summing up, we are told the fungus *Beauveria bassiana* (Bals.) Vuill. is parasitic on the coconut leaf miner (*Promecotheca cumingii* Baly) in the Philippines. This entomogenous fungus, under laboratory conditions, causes from 43 to 58 per cent. of mortality of the insect host.

In the same exchange, pp, 491-504 are given up to an article, by Claro C. Bagalso, on "Top-working old coffee trees which are poor yielders," which surely would interest any coffee planter. Unfortunately we cannot give a useful *résumé* in a few lines. Of course the idea is not a new one. Java, for instance, had made use of top-working with most encouraging results.

Quoting again from *Tropical Life,* (London) March, 1933:

The "P.A.," [Philippine Agriculturist, December, 1932] in its "College and Alumni" notes at the end, speaks of the "Mimics' Club" presenting the popular and well-beloved Gilbert and Sullivan's Opera [The Mikado] on Loyalty Day (October 10), in Baker Hall, named after our good friend, the late Professor Baker, Dean of the College. "Only praise can be given for the performance on every point," we are told, and can well believe it, especially with such interesting names for the artistes who took the parts of Yum-Yum, Pitti-Sing and Peep-Bo, as Illuminada Torres, Andrea Balbin and Virginia Mondoñedo. We should much like to have been present.

SOME THOUGHTS ON PRODUCTION

A summary of the figures of production and trade relating to plantation crops has recently been issued by the Empire Marketing Board and furnishes most interesting matter for contemplation.

The average values of the world's trade in rubber, tea or tobacco for the years 1926-31 were greater than those in beef, pork, maize or barley. In other words, on the whole, countries tend to produce their food more at home and import their luxuries from outside. The very reverse of conditions in Ceylon. A much higher proportion of the world's tobacco crops enter international trade than of dairy produce, meat or grain. To what an extraordinary state do many of the producing countries of plantation crops find themselves in the dangerous situation of depending very largely, too largely, upon one staple! The value of Ceylon's tea consists of some 52 per cent of her total exports. Sugar constitutes over three-quarters of the value of the exports of Cuba and over half of that of those of Dominica, Hawaii, Porto Rico, Barbados, British Guiana and Fiji. Brazil, Colombia, Costa Rica, Guatemala and San Salvador depend for over 90 per cent of their trade upon coffee. The Gold Coast to 80 per cent upon cocoa. One half the export trade of British Malaya is in rubber in comparison to one-fifth in the case of Ceylon. One half of the value of the export trade of Greece and three-quarters of that of Nyasaland consists of tobacco. Zanzibar lives largely on her trade in spices, mostly cloves, which constitute 68 per cent of the value of her exports. India and the United States are the largest consumers of cloves.

Whilst the Empire is the world's largest exporter of tea yet on the whole she is not a net exporter of the commodity. The Empire production and consumption approximately balance.

India's chillies go mostly to Ceylon and seven per cent of her ginger. In both of these Ceylon could be more than self-supporting. India enjoys a large export trade in ginger with Aden and Arabia, less than one-quarter of her shipments of this spice go to Europe. The sole spice in which Ceylon possesses a monopoly is cinnamon of which Mexico is the largest consumer, Spain and the United States coming next in order.

PHILIPPINE AGRICULTURIST VOL. XXII, No. 3, AUGUST, 1933

The world's total production of tobacco is more valuable than that of sugar although less than one-tenth the quantity. The average value of tobacco exported from Cuba is some £180 a ton in comparison to £123 from the United States, £89 from the Dutch East Indies and £60 from India.

The area of the world under sugar is estimated at some 20 million acres. There are over 12 million acres under coffee and about half that under tobacco. Plantation rubber covers nearly 8 million acres, cocoa about 3 1/2 million and tea under 3 million. The world's area under sugar is about one-quarter of the wheat area in Russia, which is about the same size as the rice area in India, and one-fifth of the area under maize in the United States. The world's area under coffee is less than that planted with wheat in France.

The Tropical Agriculturist (Ceylon) February, 1933

The man who thinks he knows it all has merely stopped thinking.

Penn State Farmer

I believe thoroughly in agricultural education. I regard it as one of the most important and essential branches of the whole educational effort that is being carried on in the United States. I am a firm believer also in the value of the coöperative research and experimental work and the extension service, which state institutions in coöperation with the Federal government are rendering.

I think it would be nothing short of a disaster if any of this work were seriously curtailed. Particularly in these times when farmers are having such a desperate struggle to maintain themselves.. I think it supremely important that they should have the benefit of the expert advice that colleges, experiment stations and extension services are able to give them and it is equally important that we should continue to hold out to their children opportunities for an education that will make them something more than field drudges....

FRANKLIN D. ROOSEVELT
West Virginia Farm News

A watch without hands won't tell the time of day.
A farmer without accounts doesn't know where he gets his pay.

The Agricultural Student (College of Agriculture, Ohio State University)

A PRELIMINARY STUDY OF PUPILS IN VOCATIONAL AGRICULTURE [1]

FRANCISCO M. SACAY
Of the Department of Agricultural Education

One of the important requirements in the proper conduct of the educational process is to have a full knowledge of the pupils, or the individuals to be educated. The aim of the survey reported in this article was to discover certain characteristics of the student population in schools of agriculture of secondary grade. Such information may not only contribute to the solution of problems pertaining to the teaching process, but also aid in solving problems concerning organization and administration of vocational education in agriculture in the Philippines.

METHOD OF STUDY

The data reported in this paper were obtained through questionnaires sent to pupils through teachers who were requested by the writer to help in gathering the necessary facts. Other information was obtained from the principals of the schools included in the survey. The greater portion of these data was collected in 1931. Facts on the elimination of students were recently obtained.

PATRONAGE AREA OF AGRICULTURAL SCHOOLS

In 1932, 26 provinces in the Philippines had at least one agricultural or rural high school. In one province, there were as many as three such schools. The total number of secondary schools giving instruction in vocational agriculture numbered 31 in 1932.

In studying an agricultural school, the first question which should be answered is: Where does the student body of the school come from? What is the size of the patronage area of the school? Is the whole province served by the agricultural school of that province? The figures in table 1 attempt to answer these questions.

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[1] General contribution from the College of Agriculture, No. 348. Received for publication, April 12, 1933.

Materials embodied in this paper were taken from pages 192 to 203 and pages 211 to 220 of a dissertation presented by the author to the Faculty of the Graduate School, Cornell University, Ithaca, N. Y., in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

TABLE 1

Enrollment in agricultural schools and its sources

SCHOOLS	TOTAL ENROLLMENT	ENROLLMENT FROM TOWN WHERE SCHOOL IS LOCATED	ENROLLMENT FROM PROVINCE WHERE SCHOOL IS LOCATED	PUPILS COMING FROM OUTSIDE THE PROVINCE
		per cent	*per cent*	*per cent*
Rural High:				
Zambales	52	53.8	98.1	1.9
Batac	75	88.0	97.3	2.7
San Carlos ...	446	61.7	79.6	20.4
Agricultural High:				
Lagangilang ..	167	[a]	48.5	51.5
Baybay	177	19.8	68.4	31.6
Camarines	248	[a]	25.8	74.2
Trinidad	566	[a]	93.6	6.4

[a] Not reported.

It will be seen that the rural high school gets its enrollment principally from the province in which it is located. The agricultural high school, on the other hand, obtains a high proportion of pupils from outside the province. This is because agricultural schools usually have facilities for board and lodging for pupils from other towns. The other two factors which may affect the proportion of pupils coming from other provinces are the size of the province and nearness of competing schools of agriculture. The low percentage of outside students attending Trinidad is due principally to the size of the province served by the school, and the presence of agricultural schools in the nearby provinces. In the case of Camarines, the small size of the province and the absence of similar schools in nearby provinces result in a high percentage of its enrollment being from outside.

Table 1 also indicates that the patronage area of the rural high school is primarily local, as the percentage of pupils coming from the town where the school is located ranges from 53.8 to 88.0 per cent. Similar results were found by the Monroe Educational Survey Commission [2] in the case of academic high schools. The percentage of high school enrollment in academic high schools coming from within a radius of 20 kilometers ranges from 43.0 to 58.5 per cent. According to the Commission the geographical factor is important in determining attendance.

[2] The Board of Educational Survey. 1925. A survey of the Educational System of the Philippine Islands. (By Monroe Commission) 677 p. Manila: Bureau of Printing.

The high percentage of pupils in a rural high school coming from the province where the school is located has a great significance on the nature of contents of the subjects in agriculture taught in these schools. It indicates that much attention should be given to the problems and needs of the system of farming found in the province.

AGE OF PUPILS IN AGRICULTURAL SCHOOLS

A total of 339 pupils were included in this study. These pupils were distributed among the following schools: Bunawan, Central Luzon, and Mampising agricultural high schools, and Nueva Vizcaya rural high school.

TABLE 2

Ages of pupils in five schools of agriculture

AGE IN YEARS	FIRST YEAR	SECOND YEAR	THIRD YEAR	FOURTH YEAR
13	—	1	—	—
14	2	1	1	—
15	9	3	—	—
16	16	9	1	—
17	21	13	3	—
18	18	22	12	7
19	9	9	13	8
20	11	17	19	18
21	1	9	14	7
22	9	4	13	18
23	2	1	8	14
24	2	1	1	6
25	1	—	2	8
26	1	—	2	2
27	—	—	1	3
Median (years)	16.9	17.8	19.8	21.3

• In table 2 is shown the range of ages of these pupils. The youngest pupil is 13 years and the oldest is 27 years. The median ages for the different years are as follows: first year, 16.9 years; second year, 17.8; third year, 19.8; fourth year, 21.3 years. It will be seen that agricultural pupils are relatively mature. The Monroe Commission found a similar situation in academic high schools. The Philippine pupils when they enter high schools are about three years older than those in the United States who usually enter high school at 14 or 15 years of age. The agricultural pupil is therefore physically mature for the task which he has to do in the school. For

the school administrator another significance of this finding is in deciding the grade in the school system at which instruction in vocational agriculture may be given.

SOCIAL BACKGROUND OF AGRICULTURAL PUPILS

A knowledge of the social group from which the pupils come will indicate to the school administrator their previous experiences and probable attitude towards the vocation for which they are being trained. A total of 381 pupils from five schools indicated the occupation of their parents. As shown in table 3, 307 are sons of farmers. This number comprises 80.6 per cent of the total. The Monroe Commission reported that in the academic high schools, 55.5 per cent of pupils are sons or daughters of farm owners and tenants, indicating the importance of the agricultural industry in the Philippines. In the State of New York, Dr. T. H. Eaton[3] found that 77.8 per cent of parents of pupils enrolled in vocational agriculture were engaged in occupations of agricultural nature. It appears that the schools of agriculture in the Philippines attract pupils who have had previous experiences in farm life and are agriculturally inclined.

TABLE 3

Occupation of fathers of pupils in agriculture

OCCUPATION	AGRICULTURAL HIGH SCHOOLS			RURAL HIGH SCHOOLS		TOTAL
	Central Luzon	Bunawan	Mampising	Nueva Vizcaya	Zambales	
Farming	94	83	46	57	27	307
Commerce	3	2	0	2	3	10
Skilled labor	3	1	2	4	1	11
Unskilled labor	3	0	1	1	0	5
Profession	2	0	1	0	1	4
Clerical	0	1	0	0	0	1
Fishing	3	0	1	0	0	4
Soldier	0	1	1	2	0	4
None	1	5	0	1	0	7
Not reported	1	4	1	6	0	12
Deceased	5	5	2	2	2	16
Total	115	102	55	75	34	381

SIZE OF FARMS OPERATED BY PARENTS

Whether the agricultural pupil will return to the farm and engage in farming after leaving school greatly depends upon the size

[3] EATON, T. H. 1922. Vocational education. Rural School Survey of New York State. 293 p. Ithaca, N. Y.

of the farm operated by his father. Replies from 296 pupils distributed in five schools were received. As shown in table 4, 149 of the 296 pupils have parents who operate one to five hectares. Many in this group operate two to three hectares. In other words, 50.3 per cent of the home farms are less than five hectares in size. This small area indicates that many of these pupils will not be able to farm at once after leaving school because their fathers will not need their assistance, nor will their farm support a fair standard of living for a larger number of mature individuals. Consequently, many students are attracted to other types of work, as will be revealed from a study of their vocational intentions.

TABLE 4

Size of farms operated by pupils' parents

SIZE IN HECTARES	CENTRAL LUZON	BUNAWAN	MAMPISING	NUEVA VIZCAYA	ZAMBALES	TOTAL
1-5	55	24	10	44	16	149
5-10	16	33	10	6	7	72
10-15	6	8	3	3	1	21
15-20	2	8	5	—	3	18
20-25	6	8	6	2	—	22
25-50	4	2	4	—	—	10
50-75	1	—	1	—	—	2
75-100	—	—	2	—	—	2
Total	90	83	41	55	27	296

PERSISTENCE OF AGRICULTURAL PUPILS

In the study of school persistence among students in agriculture, 202 distributed among three schools were included. These pupils entered the high schools either in 1928 or in 1929. The number completing the different high school grades is shown in table 5. It will be seen that 79.7 per cent of the original number successfully completed the first year. Less than one-half of the number which entered the agricultural school completed the course. Although two-thirds completed the second year, the number which continued to the third year and completed that year amounted to only 49 per cent of the original number. The factors which contributed to the elimination of many pupils were as follows: lack of financial support, poor health, lack of interest in the work, and poor scholastic achievement.

The fact that many pupils do not go beyond the second year points to the importance of making the first two years of the curriculum of the greatest possible value to the prospective farmers.

TABLE 5

Persistence of agricultural pupils in school

SCHOOLS	STARTED	COMPLETED 1ST YEAR	COMPLETED 2ND YEAR	COMPLETED 3RD YEAR	COMPLETED 4TH YEAR
Batac Rural High	68	51	39	31	30
Indang Rural High	57	43	35	25	23
Lagangilang Agric. High	77	67	64	43	33
Total	202	161	138	99	86
Percentage	100	79.7	68.3	49.0	42.6

OCCUPATIONAL INTENTION OF PUPILS

Of the 381 pupils in five schools, 144, or 37.8 per cent of the total number, signified their intention to engage in farming at once after leaving school, as shown in table 6. Others, amounting to 24.1 per cent, declared their intention to become farmers after saving sufficient capital from earnings in other lines of work. The proportion intending to teach was 24.4 per cent. The remaining 13.7 per cent reported their intention to engage in various occupational pursuits. Almost all of the pupils expressed a hope that they would be able to own and manage a farm bought with their savings within a reasonable number of years. Doctor Eaton found that about 76 per cent of New York students in agriculture intended to farm after leaving school.

In table 6 is also shown the vocational choice of pupils according to his grade in school. One noticeable fact discovered is that among first year pupils a high percentage (58.0 per cent) desire to farm. Among fourth year pupils the percentage is only 22.8 per cent. On the other hand, the percentage of those selecting teaching is higher in the fourth than in the first year. If these figures are representative it seems that the longer the pupils stay in high school, the less the chances of their going into actual farming. This difference in attitude may be due in part to the fact that the advanced pupils realize more clearly than the younger ones that they will not have sufficient capital when they graduate to start farming. To give an accurate explanation of the situation would require further study.

TABLE 6

Percentage of pupils intending to engage in different vocations

OCCUPATIONS	FIRST YEAR	SECOND YEAR	THIRD YEAR	FOURTH YEAR	ALL PUPIL'S
	per cent	*per cent*	*per cent*	*per cent*	*per cent*
Farming, after leaving school	58.0	32.9	34.0	22.8	37.8
Farming, as soon as enough capital is accumulated	14.0	30.8	29.7	23.9	24.1
Teaching	18.7	24.2	20.9	34.8	24.4
Commerce	1.9	——	——	1.1	.7
Skilled labor	.9	1.1	2.2	3.3	1.8
Forestry	——	2.2	5.5	2.2	2.3
Clerical work	——	——	——	4.3	1.4
Professional service	3.7	7.7	1.1	3.3	3.9
Soldier	——	1.1	1.1	——	.5
Undecided	2.8	——	5.5	4.3	3.1
Total	100.0	100.0	100.0	100.0	100.0

SUMMARY

1. The patronage area of the rural high school is local in nature. The agricultural high school serves a wider area than the rural high school.

2. The median age of first year pupils is 16.9 years which is two to three years higher than the median age of the American pupils entering the high school.

3. The percentage of students coming from families engaged in agricultural pursuits is 80.6 per cent.

4. With the majority of pupils their parents' farms are not of sufficient size to enable the pupils to engage in farming when they leave school.

5. Of the number of pupils enrolled in the first year, only 42.6 per cent completed the course.

6. Only about two-fifths of the pupils intend to farm at once when they leave school. Another fifth intend to farm if they can get or soon accumulate sufficient capital. The lack of available farms and necessary capital hinders many pupils from going direct to the farm.

THE EFFECT OF DIFFERENT SOIL MEDIA ON THE RATE OF GROWTH OF CACAO (THEOBROMA CACAO L.) SEEDLINGS [1]

PEDRO Z. MADRID

WITH SEVEN TEXT FIGURES AND TWO CHARTS

The importance of soil media in determining and governing the vigor and growth of plant seedlings has been a subject of investigation for many years. Much work has been done on determining the best combinations of soil media for various crops. Very little, if any, specific information has been obtained, however, regarding the best soil medium, under nursery conditions, for seedlings of *Theobroma cacao* L. It was for this reason that the present study on the effect of different soil media on the rate of growth of cacao seedlings was undertaken.

REVIEW OF LITERATURE

Holloway (1884) stated that nurseries either in beds, pots, bamboo joints or baskets filled with a selected stiff good soil serves as a good planting medium. He pointed out that on no account should sandy soil be used for a nursery. He also suggested that seeds should be planted with the part nearest the raceme down; if planted otherwise, the roots will come up and then turn back again to the soil.

To quote Woods (1901) "Many agricultural plants have been more or less adapted to soils of a certain texture. If an attempt is made to grow a crop in soil not well adapted to it the crop is likely to suffer, unless the skill of the cultivator is able to modify the conditions of growth to meet the requirements of the crop."

According to Lyon (1905) a rich top dressing of well decomposed leaf mold mixed with sand will stimulate the early growth of cacao seedlings, and the production of stocky growth is encouraged when its roots enter the heavier soil below. He advised that the selected seed bed should be in a well shaded spot and, if possible, upon a rather stiff, plastic, but well-drained soil.

[1] Thesis presented for graduation, 1933, with the degree of Bachelor of Science is Agriculture from the College of Agriculture, No. 351; Experiment Station contribution, No. 894. Prepared in the Department of Agronomy under the direction of Dr. Pedro A. David and Dr. Nemesio B. Mendiola.

Wright (1907) recommended bamboo joints as pots in which to plant cacao seeds. In transplanting the seedlings with this type of pot there is little interruption of root development.

Barrett (1913) stated that sandy soils which are not very well watered, and are rich and deep can not be recommended for growing cacao. He also suggests the bamboo pot as being the simplest and safest container for germinating the seed. The seed should be placed horizontally at a depth of about three centimeters below the surface of the soil; the earth should not be pressed over the seed.

Van Hall (1914) recommends that the soil used in the nurseries should be fertile, friable and well drained, and that compost or farm yard manure should be applied as it is always beneficial to the cacao seedlings.

Quoting Van Slyke (1920), "farm manure in generous amounts, especially when used fresh, generally stimulates the growth of stems and leaves in a marked way, a condition characteristic of a high proportion of available nitrogen relative to available phosphorus and potassium. Under ordinary conditions, farm manure is regarded as a nitrogenous plant-food and as unbalanced with reference to the needs of most crops, relatively lacking in available phosphorus and potassium."

He also states that if nitrogen is lacking, there will be a decreased or stunted growth of the whole plant.

Wester (1920) stated that the best germinating medium for cacao seeds is made up of a light sandy soil, fairly rich in humus, the particles of which can be easily pushed apart by the tender plant in its endeavor to penetrate the soil to the surface. For potting purposes, soil similar to that used in the seed bed may be used, but preferably a fairly heavy rich loam.

Barrett (1928) advises that one seed be planted in a bamboo joint. Germination is thus insured and the seedling can be kept until it shows six to eight leaves.

Williams (1929) states that the best soil for potting is prepared from a good fibrous turfy loam taken from old pastures and mixed with good cow manure or rotten leaves.

OBJECT OF THE PRESENT WORK

The object of the experiments reported in this paper was to determine which soil medium is best for the growth of cacao seedlings under nursery conditions in the College of Agriculture.

TIME AND PLACE OF THE PRESENT WORK

This work was carried out in the Department of Agronomy, College of Agriculture, University of the Philippines, Los Baños, Laguna. The experiment was begun in April, 1931, and closed in September, 1932.

MATERIALS AND METHODS

Materials used

Source of variety. The seedlings used in this experiment were raised from freshly harvested cacao pods of the Forastero type growing in the College Plateau Cacao Plantation. Only large and well-formed seeds were selected. The seeds were planted directly in bam-

Fig. 1.—*Theobroma cacao* L. seedlings eight months old. (*a*) Grown in ordinary garden soil; (*b*) in forest soil.

boo pots containing different soil mixtures. Before sowing, the viscous pulp adhering to the integument of the seeds was removed by rolling them in dry ashes on a piece of cardboard. The pulp might induce fermentation which would have a very bad effect on the germinating embryo. Also seeds with the pulp left on are likely to be attacked by ants and other organisms that may be present in the different soil media.

Bamboo pots. Bamboo pots of uniform size were used in this study because they were easily procured and were found to be adapted for raising cacao seedlings. The bamboo pots used varied in length from 30.5 to 32.6 cm. and from 7.5 to 8.5 cm. in diameter. Three small holes were made in the closed end of each pot and small stones placed in the bottom for drainage.

Different soil media. In the preparation of the different soil media the following materials were used: (*a*) forest soil; (*b*) ordinary garden soil; (*c*) sand; (*d*) compost; (*e*) chicken manure; and (*f*) horse manure.

Undecayed leaves and twigs found mixed with the forest soil, the ordinary garden soil and the compost were removed by sifting, as they might contain fungi or bacteria that would be injurious to the cacao seedlings. To make it uniform in texture the fresh water sand which was gathered from the shore of Laguna de Bay was sifted through one-eighth inch mesh wire sieve.

The chicken manure was gathered from the chicken houses of the Poultry Division, College of Agriculture. Before the chicken manure was used, it was sun-dried and thoroughly pulverized.

Fig 2.—*Theobroma cacao* L. seedlings eight months old. (*a*) Grown in one-half forest soil and one-half compost; (*b*) in sand.

The horse manure was gathered from the pit of the Animal Husbandry Department. It was also sun-dried and pulverized.

With these materials the following media were prepared in the laboratory:

(1) Forest soil, (2) ordinary garden soil, (3) sand, (4) one-half forest soil and one-half compost, (5) one-half ordinary garden soil and one-half compost, (6) one-half sand and one-half compost, (7) three-fourths forest soil and one-fourth chicken manure, (8) three-fourths ordinary garden soil and one-fourth chicken manure, (9) three-fourths sand and one-fourth chicken manure, (10) one-half forest soil and one-half horse manure, (11) one-half ordinary garden soil and one-half horse manure, (12) one-half sand and one-half horse

manure, (13) one-third sand, one-third ordinary garden soil and one-third horse manure, and (14) one-third sand, one-third ordinary garden soil and one-third chicken manure.

These respective numbers of the soil media will be used in the discussions in this paper.

Methods

Analyses of samples of the different soil media. The determination of total nitrogen, (N), phosphorus pentoxide, (P_2O_5), and potash, (K_2O) of the different soil media used in this experiment were made through the coöperation of the Soils and Chemistry departments.

Planting the seeds and care of the seedlings. Twenty cacao seeds of uniform size were planted in each soil medium. The seeds were planted singly in a bamboo pot at a depth of about 3.0 cm. Each seed was planted in proper position, that is, the part nearest the raceme downward, if planted in the reverse position the hypocotyl will lengthen before the cotyledons rise above the ground. After all the seeds had been planted in the different soil media, the pots were carefully watered and labelled. The pots in each lot were numbered for convenience in taking measurements. They were then placed under the shade about 15 cm. apart and all plants were treated alike during the progress of the experiment. Watering and weeding were done whenever necessary.

Observation of growth. Monthly measurements on the growth of the individual plants in each lot were made. These measurements were: (*a*) monthly increase in number of leaves; (*b*) monthly increase in elongation of stem; and (*c*) monthly increase in the diameter of stem.

(*a*) *Monthly counting of the number of leaves.* The seeds were sown on May 12, 1931, and on June 10, 1931 or 29 days after sowing, the initial counting of the number of leaves on each individual seedling was made. The countings of the leaves were made in order of development, that is, from the oldest to the youngest leaf. The leaves were carefully handled, so that they were not in any way disturbed.

(*b*) *Monthly measurements of elongation and increase in diameter of stems.* These measurements were taken on the same day the leaves were counted. The increase in diameter of the stems was measured by the use of a caliper. A base mark was made at exactly 1.0 cm. from the terminal bud so as to avoid error due to sinking of

the level of the soil in the pots. This mark was also used as base mark for all subsequent measurements of the stem elongation and as a fixed point where the monthly measurement of diameter was made. The marks were renewed at time of measurement so as to keep them always visible. The measurements of elongation and increase in diameter of stem as well as the counting of the number of leaves were taken every 31 days.

RESULTS

The results obtained in the experiments are given in tables 1 to 3, in charts 1 and 2 and illustrated in figures 1 to 7.

Table 1 presents the results of the analysis of the different soil media used.

The direct associations of the different constituents in the soil media and the monthly mean increase in number of leaves, elongation of stems, and diameter of stems were determined. These results are presented in table 2.

Table 3 shows the summary of results with brief notes on the general appearance of the seedlings in the different soil media.

DISCUSSION OF RESULTS

Effects of the different soil media on the number of leaves produced

It was noted that the different soil media had very distinct effects upon the number of leaves produced (*see* fig. 1-7). The greatest total average increase in production of the number of leaves in all the treatments was during the fourth month after planting. Later the number of leaves produced gradually decreased.

The average monthly increase in the number of leaves of the cacao seedlings for a period of eight months varied from 0.2 to 4.4. The seedlings grown in medium No. 3 (sand) gave an average increase of only 0.2 at the eighth month after planting. An average increase of 4.4 was found in medium No. 8, (three-fourths ordinary garden soil and one-fourth chicken manure) four months from the date of planting the seeds.

All the soil media except that of No. 3, (sand) and No. 5, (one-half ordinary garden soil and one-half compost) gave after eight months practically the same average total increase in the number of leaves (*see* chart 1).

The average total increase in the number of leaves at the close of this experiment varied from 9.4, as noted in medium No. 3 (sand) to 17.7 in medium No. 5 (one-half ordinary garden soil and one-half compost).

The frequency distribution of the monthly increase in the number of leaves of cacao seedlings in the different media was made and it was found that the monthly mean increase of leaves in the different media varied from 1.42 ± 0.06 in medium No. 3 (sand) to 2.62 ± 0.08 in No. 5 (one-half ordinary garden soil and one-half compost). Comparing medium No. 5 with the other media, a mean difference of more than 3 times its probable error was found, with the possible exception of medium No. 10 (one-half forest soil and one-half horse manure). This seems to indicate that media No. 5 and No. 10 had the same influence on the average monthly increase of leaves of the cacao seedlings. The standard deviation and coefficient of variability were calculated for each treatment and it was found that there was no direct relation between them. Each soil medium had a different coefficient of variability. The seedlings in medium No. 6 showed the highest coefficient of variability, while the lowest was found for medium No. 11 (one-half ordinary garden soil and one-half horse manure).

Fig. 3.—*Theobroma cacao* L. seedlings eight months old. (*a*) Grown in one-half sand and one-half compost; (*b*) in one-half ordinary garden soil and one-half compost.

Effects on the elongation of stems of the seedlings

The shortest average monthly increase in the elongation of stems was found to be 0.08 cm. in medium No. 1 (forest soil) while the

longest was 6.26 cm. medium No. 8 (three-fourths ordinary garden soil and one-fourth chicken manure). The greatest average total increase after the eighth month was obtained in medium No. 5 (one-half ordinary garden soil and one-half compost). The results show that different soil media have different effects upon the elongation of stems of cacao seedlings. This is further illustrated in figures 1 to 7 and chart 1. It was also observed that the longest total average elongation of the stem occurred after the fourth month from planting. This observed monthly total average elongation of the stems gradually decreased as the seedlings approached the age of eight months. The average total increase after eight months varied

Fig. 4.—*Theobroma cacao* L. seedlings eight months old. (*a*) Grown in three-fourths ordinary garden soil and one-fourth chicken manure; (*b*) in three-fourths forest soil and one-fourth chicken manure.

from 7.79 cm. in medium No. 3 (sand) to 26.68 cm. in medium No. 5 (one-half ordinary garden soil and one-half compost).

The frequency distribution of the monthly increase in the elongation of stems under each treatment for a period of eight months was made. Media Nos. 3 (sand) and 5 (one-half ordinary garden soil and one-half compost) gave means for elongation of stems, 1.06 $\pm$ 0.05 and 3.81 $\pm$ 0.14 cm., respectively. Comparing medium No. 5 with the other media a significant difference was found except in the case of media Nos. 8, (three-fourths ordinary garden soil and one-fourth chicken manure) and 11, (one-half ordinary garden soil and one-half horse manure). Media Nos. 8 and 11 gave practically the same mean of elongation of stems as that of No. 5 (*see* chart 1).

The media which gave the greater increase in the elongation of the stem invariably showed higher standard deviation than medium No. 3 (sand). These different media showed no significant difference in their coefficient of variability as compared with medium No. 5.

Effects on the increase in diameter of the stem

The results for the average monthly increase in the diameter of stems of cacao seedlings as influenced by the different soil media show that the lowest average increase in the diameter of the stem was found in medium No. 3 (sand), and the highest was observed in medium No. 8 (three-fourths ordinary garden soil and one-fourth

Fig. 5.—*Theobroma cacao* L. seedlings eight months old. (*a*) Grown in one-half forest soil and one-half horse manure; (*b*) in three-fourths sand and one-fourth chicken manure.

chicken manure) which were found to be 0.02 and 0.13 cm., respectively (*see* chart 2). The highest total average increase in the diameter of cacao seedlings was observed after two months from the date of planting. The average total increase after eight months for medium No. 3 was only 0.25 cm. and for medium No. 11 (one-half ordinary garden soil and one-half horse manure) it was increased to 0.58 cm.

The mean increase in the diameter of the stem per month, standard deviation and coefficient of variability, were calculated for each medium. The lowest mean increase per month in the diameter of the stem was observed to be 0.04 ± 0.004 for medium No. 3 (sand). When medium No. 5 was compared with the other media, a significant difference was noted. Exceptions were observed in media Nos. 8,

(three-fourths ordinary garden soil and one-fourth chicken manure), and 11 (one-half ordinary garden soil and one-half horse manure).

The different treatments show a range in their means from 0.04 $\pm$ 0.004 to 0.08 $\pm$ 0.001. Seedlings in medium No. 3, were found to be more variable than those in other media.

Table 3 presents the summary of results obtained from the different media used in this experiment. The means of the monthly increase in the number of leaves in the different media were compared with mean of medium No. 5 to determine whether or not there was really a significant difference. All differences marked with superscript *a* were found insignificant as compared with medium No. 5 (one-half ordinary garden soil and one-half compost). The other media showed significant differences in favor of medium No. 5.

Fig. 6.—*Theobroma cacao* L. seedlings eight months old. (*a*) Grown in one-half sand and one-half horse manure; (*b*) in one-half ordinary garden soil and one-half horse manure.

Taking the mean of medium No. 5 as the standard, it was compared with the mean of the monthly increase in elongation of the stems found for each medium. The results of these comparisons are given in column 4 of table 3. In media marked with superscript *a* no significant difference was found.

Comparing the means of the monthly increase in the diameter of the stems for each soil medium as shown in table 3 with that of No. 5, a significant difference was noted in each case, except those marked with superscript *a*.

Summarizing these results, it is obvious that media No. 5 (one-half ordinary garden soil and one-half compost), No. 8 (three-fourths ordinary garden soil and one-fourth chicken manure) and No. 11

(one-half ordinary garden soil and one-half horse manure) gave practically the same results or influence on the increase of number of leaves, elongation, and diameter of stems. For similarity of the plants grown in these different media see figures 3b, 4a, and 6b.

Relation of the growth of the seedlings to the analyzed constituents in different soil media

It will be noted that for each soil medium different amounts of the important constituents were determined.

In the study of relationships between total nitrogen and monthly mean increase in number of leaves, a correlation coefficient of 0.75 ± 0.08 was determined. The results of this experiment show that the increase in number of leaves depends upon the total available nitrogen

Fig. 7.—*Theobroma cacao* L. seedlings eight months old. (*a*) Grown in one-third sand, one-third ordinary garden soil and one-third chicken manure; (*b*) in one-third sand, one-third ordinary garden soil and one-third horse manure.

and not upon the percentage of total nitrogen indicated by chemical analysis. This conclusion is corroborated by the results obtained by Gaton (1930). He claimed that, "The poor rice soils contain plenty of nitrogen in the potential form, but apparently they have poor nitrifying power and do not convert the nitrogen into assimilable form. That medium rice soils, however, gave less percentage of total nitrogen but a large amount of nitrate." It will also be noted that medium No. 3 (sand), which has the least amount of total nitrogen as analyzed, produced the lowest mean increase in number of leaves. This very low production of number of leaves was probably due to deficiency in its nitrogen content as shown in table 1. Woods (1901) states that nitrogen is responsible for the vegetative growth and if not present in proper amounts in the soil it will result in the reduc-

tion of leaf and stem growth of plants. This opinion was supported by Van Slyke (1920) in the statement, that if nitrogen is lacking, the result will be the general decrease or stunted growth of the whole plant.

As shown in table 2 the correlation between total nitrogen and the mean increase in elongation of stems was also high. But it is to be noted that media which gave high nitrogen contents as analyzed did not produce greater monthly mean elongation of stem. This may

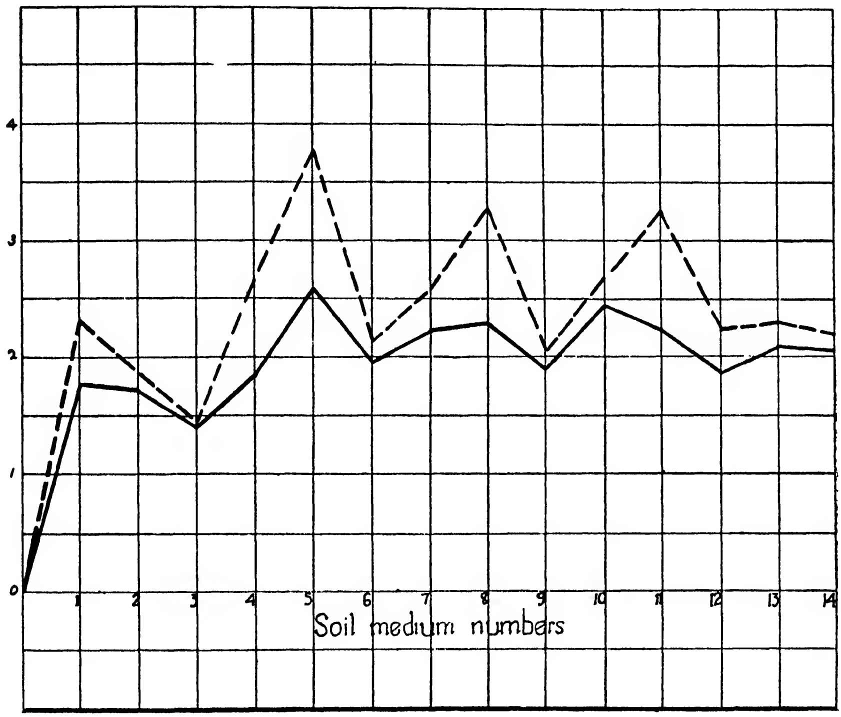

Chart 1.—Legends: ——Effects of the different soil media on the mean increase in number of leaves of *Theobroma cacao* Linn. seedlings.
- - - - Effects of the different soil media on the mean increase in the elongation of stems of *Theobroma cacao* Linn. seedlings. (In centimeters.)

be explained in the same way as in the case of the relationship between nitrogen content of the soil and that of the increase in the number of leaves. These findings tend to show that nitrogen content of the soil as a result of analysis does not give the amount present in assimilable form. It cannot then be assumed that soil medium fit for the raising of cacao seedlings can be chosen by the results of chemical analysis alone. It is quite possible for soil medium to

contain all the nitrogen required for the growth of the cacao seedlings and yet be unsuitable owing to the nitrogen being present in unavailable form.

In the case of the relationship between total nitrogen content and the monthly mean increase in the diameter of stem, the correlation coefficient was determined to be 0.72 ± 0.09. It will be noted, however, that the media which produced a large diameter of stem did not show a high percentage of nitrogen. This again may be explained by the fact that all nitrogen present in the media was not in available form for the growth of the young plants.

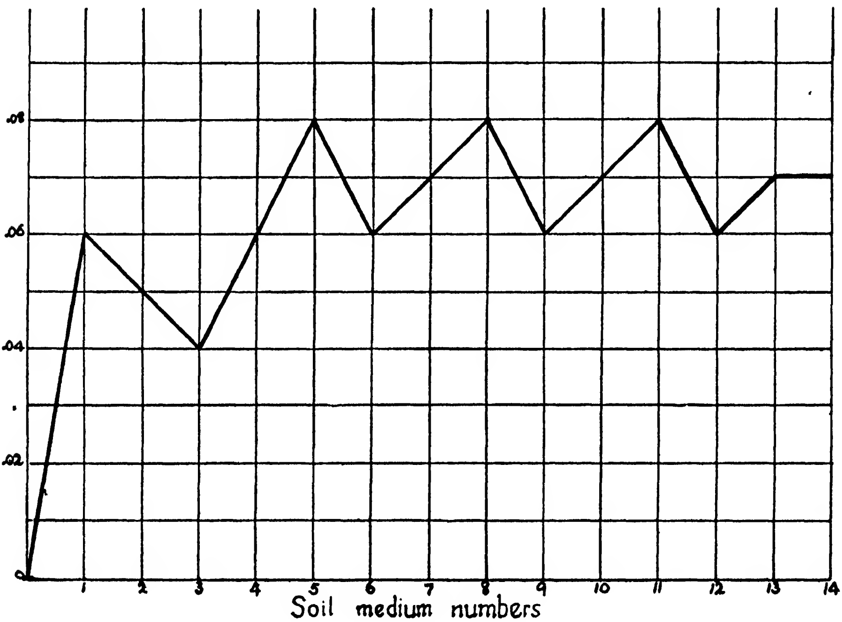

Chart 2.—Legend: ——Effects of the different soil media on the mean increase in the diameter of stems of *Theobroma cacao* Linn. seedlings. (In centimeters.)

The coefficients of correlation between the monthly mean increase in number of leaves, elongation of stems, increase in diameter of the stems and the total amount of phosphoric acid are all very high. It will be noted that media Nos. 7, 8, 10 and 11 contained high phosphoric acid content but did not show high increase in number of leaves, elongation, and diameter of stems. This tends to show that the phosphoric acid found by chemical analysis was not all in available form for the proper growth of the young plants.

The potash content of the media was found to have very little effect on the characters studied. The coefficients of correlations are all insignificant and negative.

The correlation coefficient between moisture content of the media and the mean increase in number of leaves, elongation and diameter of stems are significant, but media which showed high moisture content did not in general produce more leaves, longer and larger stems. These results seem to indicate that all the moisture present in the media analyzed was not in available form or in proper amount for the best growth of the young plants. The bad effect of the insufficiency of moisture in the soil may be seen in medium No. 3 (sand) which contained only 0.33 per cent moisture and gave the poorest results. Water is very necessary for the growth and development of plants and it has been found that nitrification can not take place in soil deficient in moisture.

From the results given in table 2, it may be noted that the total nitrogen, phosphoric acid and moisture content of the media are directly associated with the characters studied. But there is negative and very small correlation between potash and the characters analyzed as shown by the data in table 2.

SUMMARY

1. A soil medium consisting of a combination of equal proportions of ordinary garden soil and compost gave the best results for the rapid growth and development of cacao (*Theobroma cacao* L.) seedlings.

2. The ordinary garden soil and sand were found to be poor soil media for cacao seedlings.

3. Suitable soil medium for the raising of cacao seedlings can not be chosen from the results of chemical analysis alone.

4. Cacao seedlings when planted in a suitable soil medium will be ready for transplanting in about three to four months from the time the seeds are sown.

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TABLE 1

Analyses of the different soil media

NO.	SOIL MEDIA	TOTAL NITROGEN	TOTAL PHOSPHORIC ACID (P_2O_5)	TOTAL POTASH (K_2O)	MOISTURE
		per cent	*per cent*	*per cent*	*per cent*
1	Forest soil	0.31	0.09	0.22	7.76
2	Ordinary garden soil	0.11	0.07	0.32	6.18
3	Sand	0.03	0.03	0.76	0.33
4	One-half forest soil and one-half compost	0.55	0.21	0.31	8.81
5	One-half ordinary garden soil and one-half compost	0.40	0.19	0.16	7.24
6	One-half sand and one-half compost	0.10	0.05	0.26	2.07
7	Three-fourths forest soil and one-fourth chicken manure	0.42	0.32	0.22	6.50
8	Three-fourths ordinary garden soil and one-fourth chicken manure	0.32	0.30	0.90	6.57
9	Three-fourths sand and one-fourth chicken manure	0.22	0.05	0.62	0.67
10	One-half forest soil and one-half horse manure	0.56	0.31	0.13	8.67
11	One-half ordinary garden soil and one-half horse manure	0.37	0.26	0.16	8.47
12	One-half sand and one-half horse manure	0.21	0.04	0.18	1.19
13	One-third sand, one-third ordinary garden soil and one-third horse manure	0.31	0.07	0.08	2.48
14	One-third sand, one-third ordinary garden soil and one-third chicken manure	0.38	0.08	0.09	2.64

TABLE 2

Coefficients of correlation between total nitrogen, phosphoric acid, potash, moisture and the three characters studied

CHARACTERS	CORRELATION COEFFICIENTS			
	Total nitrogen	Phosphoric acid	Potash	Moisture
Monthly mean increase in number of leaves	0.75 ± 0.08	0.82 ± 0.06	-0.38 ± 0.15	0.52 ± 0.13
Monthly mean increase in elongation of stems	0.67 ± 0.10	0.75 ± 0.08	-0.24 ± 0.17	0.65 ± 0.10
Monthly mean increase in diameter of stems	0.72 ± 0.09	0.89 ± 0.04	-0.27 ± 0.17	0.54 ± 0.13

TABLE 3

Summary of results

NO.	SOIL MEDIA	MONTHLY MEAN INCREASE IN NUMBER OF LEAVES	MONTHLY MEAN INCREASE IN ELONGATION OF STEMS	MONTHLY MEAN INCREASE IN DIAMETER OF STEMS	GENERAL APPEARANCE OF THE CACAO SEEDLINGS
		difference	*difference*	*difference*	
1	Forest soil	0.35 ± 0.10	1.47 ± 0.17	0.02 ± 0.002	Growth fair, leaves small and pale green
2	Ordinary garden soil	0.89 ± 0.10	1.83 ± 0.15	0.03 ± 0.002	Very poor growth, leaves very small and pale green
3	Sand	1.20 ± 0.10	2.75 ± 0.14	0.04 ± 0.004	Growth very poor, stunted, leaves very small and pale green
4	One-half forest soil and one-half compost	0.73 ± 0.11	1.15 ± 0.17	0.02 ± 0.002	Fair growth, leaves medium size and green
5	One-half ordinary garden soil and one-half compost	2.62 ± 0.08	3.81 ± 0.14	0.08 ± 0.001	Growth excellent, leaves uniform, broad and dark green
6	One-half sand and one-half compost	0.66 ± 0.17	1.65 ± 0.16	0.02 ± 0.001	Growth fair, leaves very small and pale green
7	Three-fourths forest soil and one-fourth chicken manure	0.35 ± 0.12 [a]	1.19 ± 0.18	0.01 ± 0.002	Fair growth, leaves medium in size and dark green
8	Three-fourths ordinary garden soil and one-fourth chicken manure	0.32 ± 0.10 [a]	0.44 ± 0.19 [a]	none [a]	Growth very good, leaves broad and dark green
9	Three-fourths sand and one-fourth chicken manure	0.68 ± 0.10	1.72 ± 0.17	0.02 ± 0.002	Growth very poor, leaves very small, abnormally developed and pale green
10	One-half forest soil and one-half horse manure	0.15 ± 0.10 [a]	1.08 ± 0.17	0.01 ± 0.003	Very good growth, leaves broad, normally developed and dark green
11	One-half ordinary garden soil and one-half horse manure	0.37 ± 0.10 [a]	0.53 ± 0.19 [a]	none [a]	Good growth, leaves medium size and dark green
12	One-half sand and one-half horse manure	0.73 ± 0.10	1.53 ± 0.16	0.02 ± 0.011	Growth poor, leaves small and pale green
13	One-third sand, one-third ordinary garden soil and one-third horse manure	0.52 ± 0.12	1.25 ± 0.18	0.01 ± 0.002	Poor growth, leaves small and pale green
14	One-third sand, one-third ordinary garden soil and one-third chicken manure	0.57 ± 0.17 [a]	1.57 ± 0.18	0.01 ± 0.002	Growth fair, leaves medium size and pale green

[a] Insignificant.

STUDIES ON THE USE OF A PATEROS HATCHER IN INCUBATING CHICKEN EGGS [1]

CESAR B. TANTOCO

The artificial hatching of eggs has been practiced in certain parts of the world since the early stages of man's civilized existence. In Egypt and China, artificial incubation can be traced as having been practiced long before the Christian Era (Lippincott, 1927). In the passing centuries artificial incubation has been steadily developed until it plays a very important rôle in the economic life of the modern poultryman.

In the Philippines, the use of a modified form of the Chinese type of incubator in the incubation of duck eggs, mainly for the production of *balut* [2], and to a less extent for the hatching of ducklings has been used in Pateros, Rizal, for a long time, how long nobody knows, (Fronda, 1926). Although commercial poultry production is still in its infancy in the Islands, the modern method of hatching eggs artificially is rapidly gaining in importance. Prospects in this phase of poultry production is such as to merit further research to foster its development.

THE PATEROS INCUBATOR

The present work dealt with a series of experiments on incubation in which a modification of the Pateros system of incubation was used. The Pateros incubator consists of cylindrical baskets about 50 centimeters in diameter and about 95 centimeters deep. These baskets are placed inside a box insulated with rice hulls. In this incubator, heat is furnished during the early part of the incubation period by palay (whole rice) heated to about 40° to 43°C., but during the latter part of the incubation period, no additional heat is applied. The eggs are placed in these baskets during the first three weeks of incubation and after this period the eggs are arranged side by side on a hatching table to complete the hatch. When the eggs

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[2] *Balut* are eggs with the embryo developed to ages varying from 14 to 20 days.

are on the hatching table no additional heat is applied, the hatching proceeds with the heat generated by the developing ducklings themselves. The heat is maintained by placing two layers of cotton cloth over the eggs. As soon as the eggs are placed in the hatcher they are turned every four hours day and night.

In the present study, the eggs were incubated in a modern hot-water incubator during the first two weeks of the incubation period and in the latter part they were placed on a hatching table similar to the Pateros type to complete the hatch. The modern hot-water incubator took the place of the cylindrical baskets and heated palay used in the Pateros system of hatching.

Fronda (1926) in his description of the Pateros type of incubator and its operation stated that the owners of the hatcheries he visited claimed that of the entire number of eggs placed in these incubators, about 60 per cent reach the hatching table, 5 per cent become rotten, and the rest are either infertiles or with dead germs. Of the eggs placed on the hatching table, over 90 per cent hatch into strong, vigorous ducklings. He also reported that the operators claimed that cripples are not known to occur in these hatches. Burgos (1928) stated that "the owners claim that of the eggs placed in the hatcher, 60 per cent become ducks or *balut*, 5 per cent get rotten, 30 per cent *penoy* and 5 per cent *ukbo* which means eggs with dead developed germs."

OBJECT OF THE EXPERIMENT

While the Pateros type of hatcher has been successfully used in the hatching of duck eggs, its use in the hatching of chicken eggs has not yet been tried. The object of these experiments was to determine the effects upon the hatchability of chicken eggs and upon the growth, maturity, and mortality of the chicks hatched therefrom of using the modern incubator and a Pateros type of hatcher.

TIME AND PLACE OF THE EXPERIMENTS

The experiments were conducted in the Department of Animal Husbandry, College of Agriculture, University of the Philippines, at Los Baños, Laguna. They were begun in November, 1931, and closed in December, 1932.

MATERIALS AND METHODS

In this work Los Baños Cantonese eggs collected from the College flock, a six-hundred-egg Buckeye hot-water incubator, and a hatcher were used. The hatcher consisted of an ordinary wooden table, rice hulls, a buri mat, a piece of cotton cloth sufficient to cover

the table, and wooden board partitions. A balance sensitive to one-tenth of a gram was used in taking the weights of the chicks. A brooder and rearing houses were also used.

The layers that produced the eggs used in this study were fed with the College ration consisting of equal parts grain and mash. The grain part of the ration consisted of cracked corn and palay. The mash consisted of corn meal, shrimp meal, copra meal, and rice bran. In the feeding of the chicks, eggs were used to wet the corn meal and the mash during the first two weeks of the brooding period.

Three hatches were made in all. The first hatch was made on February 18, 1932. Six-hundred-and-fifty eggs were used in this setting. The eggs were incubated in the ordinary way in a six-hundred-egg Buckeye hot-water incubator during the first two weeks of the incubation period. The eggs were candled on the seventh and on the fourteenth day of incubation when the infertiles and those having dead germs were removed. The eggs that were left, numbering 415, after the fourteenth day of the incubation period were equally divided into five lots, lots I, II, III, IV, and V. Lot V was the check lot and lots I, II, III, and IV were the experimental lots and received the following treatment:

In lot I, the eggs were kept in the incubator for fifteen days and on the night of the fifteenth day the eggs were transferred to the hatcher to complete the hatch.

In lot II, the eggs were kept in the incubator for sixteen days and on the night of the sixteenth day the eggs were transferred to the hatcher to complete the hatch.

In lot III, the eggs were kept in the incubator for seventeen days and on the night of the seventeenth day the eggs were transferred to the hatcher to complete the hatch.

In lot IV, the eggs were kept in the incubator for eighteen days and on the night of the eighteenth day the eggs were transferred to the hatcher to complete the hatch.

In lot V, the check lot, the eggs were left in the incubator until the hatch was complete.

The second hatch was made on April 11, 1932. In this setting, 728 eggs were used. From these, 390 eggs were left after the second candling. The third hatch was made on May 8, 1932 when 600 eggs were placed in the incubator. After the second candling, 325 eggs were left. The eggs in both of these settings were treated like those of the first setting.

The operation of the hatching table. As described elsewhere, the hatching table consisted of an ordinary wooden table, rice hulls, a

buri mat, a piece of cotton cloth and wooden board partitions. The table was divided into four compartments. It was covered with a layer of rice hulls about five centimeters deep. The buri mat was spread over the rice hulls to prevent them from mixing with the eggs and to facilitate the turning of the eggs. The eggs were placed side by side standing on their small ends on the buri mat and covered with cotton cloth to prevent the loss of heat generated by the developing embryos.

The eggs on the hatching table were changed to different parts of the table every four hours during both the day and night. In changing, the eggs that were near the sides of the table were placed at the middle, and those in the middle were pushed toward the sides. The idea in changing was to subject, as much as possible, all of the eggs to the same condition. After changing, the eggs were covered with cotton cloth. This procedure with the eggs was repeated every four hours.

The hatcher was placed in the incubator cellar to prevent draft. The temperature of the eggs on the hatching table was recorded. Owing to lack of incubator thermometers, four one-half-minute clinical thermometers were used. In taking the temperature, the thermometers were placed on top of the eggs, the bulb of mercury touching them. The temperature was carefully regulated by means of the cotton cloth covering the eggs. Ordinarily, two layers of cloth were used, but when the temperature was too high only one layer was used and when the temperature became too low a third layer was added.

As soon as the chicks came out of the shells they were picked up and put into four boxes lined with rice hulls and the top partly covered with flannel. Each lot had one box placed near the table and properly labeled to avoid mixing the chicks. The chicks were allowed to harden in the box; about forty-eight hours after hatching the chicks were properly leg-banded and weighed.

Brooding and housing. All of the chicks were brooded together in a colony brooder house provided with a Buckeye charcoal burning brooder. Adjoining the brooder house was a yard with green grass. After about eight weeks in the brooder house the birds were transferred to the rearing houses in the yard and thereafter given the same treatment throughout.

Feeding and management. The chicks were given the same treatment from the beginning to the close of the experiments. The first feed consisted of corn meal to which one raw egg for every thirty chicks was added to moisten the feed.

After the second week the chicks were given the normal College ration consisting of equal parts by weight of grain and mash. The grain mixture consisted of one part cracked corn and one part palay. During the brooding period the mash mixture consisted of two parts shrimp meal, two parts corn meal, and six parts rice bran. Near the rearing period the mash mixture was changed gradually to rearing mash consisting of two parts shrimp meal, one part corn meal, three parts copra meal, and four parts rice bran, all by weight.

Growth record. The growth of the chicks was determined by their increase in weight every week. The weight of the individual chick was taken about forty-eight hours after hatching and weekly for three months and then monthly thereafter till they were six months old. From the beginning to the end of the experiment they were weighed in an arm balance sensitive to one-tenth of a gram.

Careful records of mortality were kept. The length of maturity of the pullets was also observed.

RESULTS AND DISCUSSIONS

Temperature of the hatching table. During the first four hours after the eggs were placed on the hatching table, the temperature was observed to become very low so that it was necessary to use three layers of cotton cloth, but after about eight hours on the hatching table the temperature began to increase. This rise and fall of temperature was regulated by means of the number of layers of cotton cloth, so that after eight hours on the hatcher only two layers of cloth were used. During warm days only one layer of cloth was used. It was not possible to keep the temperature constant throughout the incubation period because of the changes in the weather conditions.

The temperature of the hatcher as recorded by the thermometers was observed to range from 37.2°C. (98.9°F.) to 42.2°C. (108.0°F.) with an average of 39.7°C. (103.5°F.). The temperature was recorded only up to the twentieth day of the incubation period, because it was not possible for the thermometers to record accurately after that date owing to the moisture coming from the newly hatched chicks coming in contact with the bulb of the thermometer, thus lowering the temperature beyond the graduation of the thermometers used.

The effect of the hatching table on hatchability. The eggs in all the lots began to hatch on the twentieth day of incubation, and by the twenty-first day the hatch was complete. Table 1 shows the average percentage of hatchability of eggs in the different lots of the

three sets. As shown in this table the average percentage of hatchability and the corresponding probable errors by lots were: lot I, (eggs kept in the incubator for 15 days) 74.78 ± 2.11 per cent; lot II, (eggs kept in the incubator for 16 days) 72.12 ± 3.05 per cent; lot III, (eggs kept in the incubator for 17 days) 69.91 ± 4.49 per cent; lot IV, (eggs kept in the incubator for 18 days) 72.12 ± 1.82 per cent; and lot V, the check lot, 72.57 ± 3.16 per cent. The probable errors of the differences between the means and the check lot (lot V) were computed and it was found that in each case the differences were not great enough to be considered significant. For instance, the mean difference between the hatchability in lot I and lot V together with the probable error was 2.21 ± 3.80 per cent; between lot II and lot V, 0.45 ± 4.39 per cent; between lot III and lot V, 2.66 ± 5.49 per cent; and between lot IV and lot V, the difference was 0.45 ± 3.65 per cent.

From the results obtained it appears that chicken eggs may be removed from the incubator after fifteen days of incubation and transferred to a hatcher of the Pateros type and expected to give the same percentage of hatch as those kept in the incubator for twenty-one days. The value of this system may be appreciated in case there is a desire to increase the number of hatches within a certain period without a corresponding increase in the number of incubators. The eggs after fifteen days in the incubator may be taken out and placed in a hatcher to complete the hatch, thus making the incubator available for a new set of eggs. This method when employed will not only save seven days, but also reduce the consumption of kerosene. One of the difficulties that may be encountered in using this method is in maintaining the temperature. The amount of time expended in taking care of the eggs in the hatcher is another item that should be considered.

Rate of growth of chicks. Table 2 shows the average weekly weights of the chicks during the brooding period in the different lots. It may be seen from this table that a day-old Los Baños Cantonese chick hatched in the hatcher weighed on the average 27.3 grams for lot I; 28.3 grams for lot II; 28.5 grams for lot III; 28.0 grams for lot IV; while chicks hatched in the incubator weighed 27.5 grams on the average. It may be noted that there was not much difference in the weight of the baby chicks whether hatched in the hatcher or in the incubator.

In comparing the weight of the chicks used in this study with those used by the previous workers, it was found that Lindayag (1918) reported 26.5 grams average weight of Cantonese chicks

about twenty-four hours after hatching. Dangilan's chicks (1924) averaged 28.6 grams in weight after forty-eight hours. Mendoza (1927) gave 28.3 grams as the weight of the chicks after one day. Ordoveza (1927) reported 27.6 grams for chicks hatched in December, 25.4 grams for chicks hatched in February, and only 19.4 grams for those hatched in April. Zaratan (1929) and Tioaquen (1932) reported 24.4 and 24.7 grams, respectively as the average weight of chicks about forty-eight hours after hatching. As may be seen, the chicks used in this work were on an average slightly heavier than most of those used by the previous workers named.

At four weeks of age the chicks in the experimental lots were heavier than those in the check lot, though the difference was not great enough to be significant. Lot III, which was the heaviest among the experimental lots was greater by only 8.5 grams than the chicks in the check lot (lot V). At the eighth week of age the check lot became heavier than the experimental lots maintaining its place up to the end of the brooding period.

It may be seen in table 2 that during the first six weeks of the brooding period the weights of the chicks in the different lots were almost the same, but after this period the chicks in lot III and lot V showed an increase in weight and at the end of the twelfth week the chicks in lot V were the heaviest followed by those in lot III. These differences in the rate of growth in the different lots, however, were not consistent in all the three sets. The average weights of the birds at twelve weeks of age with their corresponding probable errors were: lot I, (chicks hatched in the hatcher after 15 days in the incubator) 354.1 ± 12.0 grams; lot II, (chicks hatched in the hatcher after 16 days in the incubator) 338.7 ± 15.4 grams; lot III, (chicks hatched in the hatcher after 17 days in the incubator) 380.3 ± 12.3 grams; lot IV, (chicks hatched in the hatcher after 18 days in the incubator) 345.8 ± 15.4 grams; and lot V, the check lot, 401.2 ± 15.0 grams.

• A statistical study of the average weights from the standpoint of the probable errors of the means, indicated that there was no significant difference. The difference between the average weights of the chicks in lot I and those in lot V was 47.1 ± 19.2 grams; between the chicks in lot II and those in lot V, 62.5 ± 21.5 grams; between those in lot III and those in lot V, 20.9 ± 19.4 grams; and between those in lot IV and those in lot V, 55.4 ± 21.5 grams.

When the average weights of the male and female birds in the different lots from hatch to the sixth month of age were compared it was observed that the increase in weights of the male chickens was

4. There was no significant difference in the weight of the birds in the experimental lots and those in the check lot at any time up to the age of six months.

5. The number of pullets that laid when six months old was larger in each of the experimental lots than in the check lot.

6. The percentage of mortality in no experimental lot differed very much from that of the check lot.

7. In case there is an over supply of hatching eggs and the incubator is very badly needed, the eggs after fifteen days in the incubator may be placed on a hatching table to complete the hatch.

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TABLE 1

Showing the average percentage of hatchability in the different lots of the three sets

LOT NO.	EGGS SET [a]	PIPPED		CRIPPLED		HATCHED [b]		DIFFERENCE BETWEEN EXPERIMENTAL AND CHECK LOTS
	number	*number*	*per cent*	*number*	*per cent*	*number*	*per cent*	*per cent*
I	226	8	3.54	3	1.77	169	74.78 ± 2.11	2.21 ± 3.80
II	226	13	5.75	4	2.45	163	72.12 ± 3.05	0.45 ± 4.39
III	226	6	2.65	2	1.26	158	69.91 ± 4.49	2.66 ± 5.49
IV	226	8	3.54	6	3.68	163	72.12 ± 1.82	0.45 ± 3.65
V	226	10	4.42	2	1.22	164	72.57 ± 3.16	....

[a] Eggs that were left after the second test (fourteenth day of incubation).

[b] Percentage was based on fertile eggs left after removing those whose embryos had died during the first and second weeks of incubation.

TABLE 2

Showing the average weekly weights of the birds in the different lots

AGE	LOT I			LOT II			LOT III			LOT IV			LOT V		
	Birds	Av. weights	Av. weekly gain	Birds	Av. weights	Av. weekly gain	Birds	Av. weights	Av. weekly gain	Birds	Av. weights	Av. weekly gain	Birds	Av. weights	Av. weekly gain
weeks	*number*	*grams*	*grams*	*number*	*grams*	*grams*	*number*	*grams*	*grams*	*number*	*grams*	*grams*	*number*	*grams*	*grams*
Initial	166	27.3	...	159	28.3	....	156	28.5	....	157	28.0	....	161	27.5	....
1	132	33.4	6.1	134	34.3	6.0	132	34.8	6.3	134	32.5	4.5	143	32.1	4.6
2	115	43.2	9.8	120	44.8	10.5	111	44.7	9.9	107	43.5	11.0	116	41.6	9.5
3	96	59.0	15.8	104	59.9	15.1	96	62.2	17.5	99	60.2	16.7	102	56.8	15.2
4	73	80.9	21.9	87	80.2	30.3	86	86.5	24.5	78	84.8	24.6	83	78.1	21.3
5	67	108.3	27.4	83	107.0	26.8	82	106.7	20.2	71	105.5	20.7	75	106.5	28.4
6	64	135.0	26.7	79	135.1	28.1	75	140.6	33.9	65	136.9	31.4	71	141.8	35.3
7	61	180.6	45.6	67	180.3	45.2	69	189.8	49.2	55	179.9	43.0	60	193.8	52.0
8	60	210.8	30.2	61	210.1	29.8	61	223.2	33.4	51	217.0	37.1	55	228.4	35.6
9	56	227.5	16.7	55	228.3	18.2	57	251.7	28.5	46	228.7	11.7	51	249.5	21.2
10	55	266.2	38.7	50	261.0	32.7	55	298.9	47.2	42	266.4	37.7	48	312.9	63.3
11	53	307.9	41.7	47	299.4	38.4	53	340.2	41.3	39	309.9	43.5	45	365.7	52.8
12	50	354.1	46.2	44	338.7	39.3	52	380.3	40.1	38	345.8	35.9	44	401.2	35.5

TABLE 3

Showing the weights of the birds at the age of six months

LOT NO.	MALES		FEMALES	
	Birds	Average weights	Birds	Average weights
	number	*grams*	*number*	*grams*
I	20	1253.5 ± 46.67	21	916.6 ± 38.12
II	19	1233.1 ± 45.86	21	837.2 ± 43.14
III	27	1222.7 ± 46.06	17	1036.5 ± 46.00
IV	13	1266.2 ± 62.82	15	990.3 ± 55.58
V	16	1338.8 ± 22.06	20	988.1 ± 37.75

TABLE 4

Showing the maturity in all lots of pullets raised to six months

ITEMS	LOT I	LOT II	LOT III	LOT IV	LOT V
Number of pullets raised to six months	21	21	17	15	20
Average age when first egg was laid (days)	167	156	170	165	170
Number of pullets that laid at six months of age	4	5	3	3	2
Percentage of flock laying at six months of age	19.04	23.80	17.64	20.00	10.00

A STUDY OF THE PALATABILITY AND FEEDING VALUE OF SOME PHILIPPINE PLANTS FOR GOATS [1]

FELICISIMO D. SURATOS

The fact that goats will eat even such material as paper, which is tasteless and dry, leads one to think that any kind of plant growth would be relished by them. It is also a common observation that these animals actually forage on a large variety of plants which other animals will not touch. Whether or not all common species of vegetation are palatable to goats, and if so, to what extent each species is eaten by them, formed the main subject of this study. The relative feeding value of plants tested also forms part of this work.

REVIEW OF LITERATURE ON THE SUBJECT

Pepa (1927) conducted experiments with cattle using Napier grass, Guinea grass, cogon and culape. He found that the animals readily ate these plants, Guinea grass being the most palatable, followed by Napier grass and cogon, with culape being the least palatable.

Tuya (1930) conducted a similar work with horses. Barit, Guinea grass, Napier grass, sugar cane tops and peanut hay were fed. He found that these plants were not equal in palatability, although the animals ate each of them readily. Guinea grass and barit were equal in palatability, followed by sugar cane tops, cut 15 cm. long, and Napier grass, cut 1.3 cm. Napier grass and sugar cane tops were equal in palatability when cut 1.3 cm. long. Culape and peanut hay were the least palatable, the latter being the poorest. The results also showed that barit was more palatable than sugar cane tops fed in 1.3 cm. lengths.

Soriano (1931) conducted an experiment with pigs, using *Calopogonium mucunoides* Desv. and sweet potato vines as pasture plants. The pigs on sweet potato pasture made much more gain in weight than those on *Calopogonium* pasture.

Fajardo (1931) working on horses and feeding different varieties of peanut hay, found that the Tagalog variety was the most palatable. The other varieties of peanuts were the Angat and Kinorales.

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Galang and Paulino (1925) conducted experiments with bullocks using Napier grass and Guinea grass. They found that Guinea grass and Napier grass, when cut at the age of 20 days, were equal in palatability. But cut when 30, 40, 45, 60, 75 and 90 days old the palatability of Napier grass was lower than that of Guinea grass.

OBJECTS OF THE WORK

The objects of this experiment were, (*a*) to determine the degree of palatability of 22 common Philippine plants for goats as shown by consumption records; and (*b*) to compare the proximate chemical analysis of the same plants used in the experiment.

TIME AND PLACE OF THE WORK

The work was conducted in the Department of Animal Husbandry, College of Agriculture, University of the Philippines, from June 22, 1930 to February 23, 1932, covering a period of 1 year and 8 months.

MATERIALS AND METHOD

Animals. The animals used in this experiment were of two classes, young and old.

In the first set of this experiment the 5 animals used were young, less than one year old. Animals 257 and 269 were males and the other 3 were females. Animals 261, 257 and 269 were Indian grades, the other 2, Anglo-Nubian grades. They were in good physical condition at the beginning and during the experiment. (*See* table 1.)

In the second set, there were 5 mature goats, averaging over five years of age. One of them was a castrated male, the other 4 were females. Animals 70, 78, 96 and 103 were Indian grades; the castrated animal, No. 198, was an Anglo-Nubian grade. These animals were also in good health and condition at the beginning and during the experiment. (*See* table 1.)

Plants. Twenty-two species of plants were used in this work. The description and distribution of these plants as presented by Merrill (1912) with the exception of saguing butuan and *Calopogonium mucunoides* follow:

Guinea grass (*Panicum maximum* Jacq.). This is an erect, coarse, perennial grass attaining a height of 2 to 3 m. The stem is about 1 cm. in diameter and the nodes are bearded. It is a native of tropical Africa and was introduced into the Philippines in 1907 by the Bureau of Agriculture (1911). It is cultivated in many tropical countries for forage purposes.

Napier grass (*Pennisetum purpureum* Schum). This is a coarse, perennial grass attaining a height of 5 m. or more. It is a native of tropical Africa. According to Wester (1920) this grass was introduced into the Philippines in 1918. It is cultivated for feeding purposes.

Pulang puet (*Panicum colonum* Linn.). This is a perennial grass with tufted stems attaining a height of from 10 to 40 cm. The leaves are 5 to 12 cm. long and 2 to 3 cm. wide. It is widely distributed in the Philippines, growing throughout the year mostly by the roadside, in rice and corn fields, and in open low places. Its introduction into the Philippines was incidental and its origin is not known.

Culape (*Paspalum conjugatum* Berg.). This is a gregarious grass with spreading stems, branching from the lower surface. The branches that flower are from 20 to 70 cm. high. The leaves are 8 to 20 cm. long and .5 to 1.5 cm. wide. It is a native of tropical America. It grows in many regions in the Philippines.

Sugar cane (*Saccharum officinarum* Linn.). This is a coarse, erect, perennial and usually unbranched grass with solid stem. It attains a height of from 1.5 to 3.5 m. The skin is either white, red, purplish, or yellow. It is a native of tropical Asia and is now very extensively cultivated in the Philippines for the production of sugar. The tops obtained during the harvesting period make available a large supply of forage during that season.

Cogon (*Imperata cylindrica* var Koenigii (Retz.) Benth. ex Pilger.). This grass is erect, perennial, and unbranched, attaining a height of 30 to 80 cm. The stem is solid, slender, and the leaves are flat, 20 to 50 cm. long and 5 to 9 mm. wide. It is widely distributed in the Philippines, growing mostly in dry open lands.

Aguiñgay (*Rottboellia exaltata* Linn.). This is a coarse, erect, branched, perennial grass attaining a height of 1 to 2.5 m. The stem is stout and spongy inside. The leaves are from 20 to 60 cm. long and 1 to 3 cm. wide. It is found throughout the Philippines in open well-drained grass lands and thickets.

Barit (*Leersia hexandra* Sw.). This plant is a weak, suberect slender grass reaching a height of 5 m. The leaves are from 5 to 20 cm. long and 3 to 7 mm. wide. The stem below is somewhat prostrate and usually with roots at the nodes. This is a cultivated grass grown commercially on low wet lands mainly for feeding horses.

Butterfly pea (*Centrosema plumieri* (Turp.) Benth.). This is a twining herbaceous vine with a woody base, reaching a length of more than 5 m. The leaves are trifoliate 5 to 15 cm. long. This plant is not very common in the Philippines. It is a native of South America.

Aurora (*Ipomoea triloba* Linn.). This is a twining herbaceous and slender vine. The stem is green and about 2.5 mm. in thickness. The leaves are partly or entirely trilobed and 4 to 11 cm. long. It is widely distributed in the Philippines. It is found growing in open, waste places. It was introduced into the Philippines from tropical America.

Operculina turpethum (Linn.). S. Manso. This is a scandent, herbaceous vine reaching a length of about 5 m. The stem is winged and purplish with 2 to 4 angles. It flowers from October to April. It is widely distributed in the Philippines. It is not a native of this country; it grows mostly in thickets.

Sweet potato (*Ipomoea batatas* (Linn.) Poir). This is a spreading, prostrate herbaceous tuber. The leaves are about 6 to 14 cm. long, subentire and ovate in form. It is cultivated extensively in the Philippines. It is a native of Africa.

Saguing butuan (*Musa errans* var. botoan Teodoro). This is a variety of banana which produces 4 to 8 flowering stems to the stool. The mature plants

reach a height of from 365 to 385 cm. and a diameter 17 to 20 cm. at the base. The trunk is cylindrical and smooth. The trunk and leaves are deep green. The leaves are strong in texture. The fruits vary in size but are uniform in shape. The fruits have many seeds which are used as medicine for dysentery (1915).

Culutculutan (*Urena lobata* Linn.). This is an erect, branching and shrubby plant attaining a height of .6 to 2.5 m. The leaves are 3 to 9 cm. long, with lower surface pale. It was introduced into the Philippines and at present is found growing in waste places throughout the Islands. It flowers any time of the year.

Tujod manok (*Synedrella nodiflora* (Linn.) Gaertn.). This is an erect annual dichotomously branched, glabrous herb attaining a height of about 1 m. The leaves are petioled and from 7 to 13 cm. long. This plant is found growing in open waste places, but is also quite abundant under bushes and shade trees. It is a native of Mexico. It flowers throughout the year.

Dila-dila (*Elephantopus spicatus* Aubl.). This plant is an erect, stiff, glabrous herb reaching a height of 20 to 60 cm. The leaves on the upper surface of the stem are smaller than those at the base. It is widely distributed in the Philippines, growing mostly in open waste places. It was introduced into the Philippines from tropical America.

Peanut (*Arachis hypogaea* Linn.). This is an annual, spreading, hairy, branched herb, with stem reaching a length of 30 to 80 cm. The leaves are even, pinnate, 8 to 12 cm. long and with leaflets about 2 to 5 cm. long. The pods contain from 1 to 3 seeds. The peanut is a native of tropical America and is now widely distributed in tropical and sub-tropical countries.

Ipilipil (*Leucaena glauca* (Linn.) Benth.). This is an erect shrub or small tree 2 to 6 m. high. The leaves are 15 to 25 cm. long and pinnate. It is a native of tropical America. It is widely distributed in the Philippines; grows mostly in thickets and on hillsides.

Acacia (*Samanea saman* (Jacq.) Merr.). This is a large tree with spreading branches; grows to a height of 20 to 25 m. The leaves are bi-pinnate and 15 cm. long. It flowers from March to September. This plant is native of West Indies. It is widely distributed in the tropics and is planted as shade tree along roads and around town plazas.

Cacauati (*Gliricidia sepium* (Jacq.) Steud.). This plant is a glabrous deciduous tree attaining a height of from 3 to 10 m. The leaves are about 15 to 25 cm. long with 1 to 3 leaflets arranged opposite each other except one at the terminal end. It is a native of Mexico. It is now found throughout the Philippines in thickets, hedge rows and in towns. It flowers from about December to April.

Corn (*Zea mays* Linn.). Corn is a very coarse, erect grass about 2 m. high. The leaves measure 10 cm. wide and 1 m. long. The stem is solid. The male inflorescence is borne at the terminal part of the plant, while the female inflorescence is axillary. Corn is a native of tropical America and is cultivated in all temperate and tropical countries. It was introduced into the Philippines by the Spaniards and is now widely cultivated in the Islands.

Calopogonium mucunoides Desv. This is a creeping scandent and often climbing woody vine. The stems are terete pubescent and covered with brownish, long, soft hairs. The leaves are trifoliate, borne on long pubescent peduncles and are subtended by a pair of persistent stipules. The pods also are cov-

ered with hairs. This vine is a native of Guiana. According to Soriano (1931) this plant was introduced into the College of Agriculture, University of the Philippines, Laguna, by Dr. Nemesio B. Mendiola on April 18, 1927. It is extensively grown in Java for green manuring.

Barn. The barn used in this experiment has a concrete floor. The goats were placed in sections with a wooden railing for partitions. Each inclosure is 2.5 m. square.

Feed boxes. In each pen a feed box for forage was placed. The feed box was large enough to contain more feed than an animal could consume each test period. The feed boxes rested on legs 20 cm. from the ground to enable the goats to feed comfortably.

Scales. For weighing the feeds the Renfrew portable scale was used.

Feeding and management

To make the animals more familiar with the test plants, they were fed, for a preliminary period of five days, more of the forage than they could consume. After this preliminary period, the test materials, except sugar cane tops and corn forage, were fed to all the animals for 10 days. The sugar cane tops and corn forage were fed to the mature animals for only 8 days. (*See* table 2.)

Feeding of test plants was between 6:30 a. m. and 1:00 p. m. daily. With the exception of barit, sugar cane tops and corn forage which were fed about 12 hours after they were cut, and peanut hay which was given as such, the feeds were collected about one hour previous to feeding. The feed was weighed and placed in the feed box provided in the individual inclosures where the experimental goats were kept. The feeding was carefully observed to determine the parts of the plants that were eaten. At 1:00 p. m. the left-over was weighed and the difference between this and the amount placed in the box in the morning was considered to represent the amount consumed.

After 1:00 p. m. the animals were allowed to go with the College herd to the pasture for grazing. The extra feed that the animals could obtain in the pasture was considered necessary for the proper nourishment of animals in cases where the test plants fed were poor in palatability. The goats also received grain supplements in the barn when they were brought in from the pasture in the evening.

The goats had free access to water and salt all the time they were in the barn.

Preparation of plants before feeding

Pulang puet, aguingay, Guinea grass, cogon, tujod manok, dila-dila, Napier grass, culutculutan and culape were prepared in the same manner. That is, the plants were cut at the base and given to the animals without further treatment.

Butterfly pea, aurora, sweet potato vine, *Calopogonium mucunoides* and *Operculina turpethum* are vines; they were cut into 30 cm. lengths before putting them in the feed boxes.

Cacauati, acacia and ipilipil were fed in the form of leaves and the soft portions of stems gathered from the trees bearing them.

Peanut hay was given to the animals directly after weighing it.

The sugar cane tops and corn forage were cut into 1.3 cm. lengths with a forage cutter before feeding them to the animals.

The barit used in this work came in bundles from a commercial barit plantation. The bundles were untied and then placed in feed boxes.

Banana leaves were cut into portions about 50 cm. long. In this form the animals fed on them conveniently.

Analysis of plant materials

Samples of some of the plants tested were analyzed in the Experiment Station Section of the Department of Agricultural Chemistry. Those which had been analyzed previously in the same laboratory were not submitted for analysis.

Weighing of animals

The animals were weighed at the beginning and end of each test period to find out if any radical change in weight was produced by the test plants. In no instance, however, was there any ill effect brought about by unpalatable test feed, because throughout the experiment the animals were allowed to feed in the afternoon on the pasture.

DISCUSSION OF RESULTS

Palatability with young goats

In the tests on Guinea grass, pulang puet, butterfly pea, Napier grass, sugar cane tops and culape whole plants including the leaves and stems were eaten by young goats. In the tests on aurora, *Operculina turpethum,* tujod manok, dila-dila, acacia, culutculutan, saguing butuan, ipilipil and *Calopogonium mucunoides,* only the leaves were eaten.

Superior palatability. Table 3 shows that the most palatable forage for young goats was Guinea grass of which the average consumption per head was 1.5 kgm. Assuming that all feeds of which over 1 kgm. per head was consumed were of superior palatability, it is apparent that Guinea grass, Napier grass, pulang puet, ipilipil, saguing butuan belonged to this class, the rank being in the order named. Taking Guinea grass as 100 per cent palatability, the percentage palatability of other feeds in the class are as follows: Napier grass, 84.66 per cent; pulang puet, 78.0 per cent; ipilipil, 76.66 per cent; saguing butuan, 68.66 per cent.

Medium palatability. If medium palatability is taken to include all feeds the consumption of which averaged from .76 to 1 kgm. per goat, culape, butterfly pea, *Calopogonium mucunoides*, culutculutan and sugar cane tops fall under this class in the order given. Basing computations on Guinea grass consumption, the percentage palatability of these plants are: culape, 59.33 per cent; butterfly pea, 56.66 per cent; *Calopogonium mucunoides*, 54.00 per cent; culutculutan, 52.66 per cent; and sugar cane tops, 51.33 per cent.

Poor palatability. Under poor palatability were classified plants of which an average of .75 kgm. or less per animal was consumed. Following this criterion, aurora, tujod manok, *Operculina turpethum*, acacia and dila-dila, in the order given, should fall in this class. Acacia and dila-dila were so poor in palatability that on an average their consumption amounted to only .30 and .20 kgm. per head at one feeding. Compared with the consumption of Guinea grass, the percentage palatability of plants in this class was as follows: aurora, 45.33 per cent; tujod manok, 33.33 per cent; *Operculina turpethum*, 28.00 per cent; acacia, 20.00 per cent; and dila-dila, 13.33 per cent.

Palatability with mature goats

With mature goats the leaves and stems of Guinea grass, pulang puet, butterfly pea, aurora, *Operculina turpethum*, culape, dila-dila, culutculutan, Napier grass, peanut hay, sugar cane tops, *Calopogonium mucunoides*, aguingay, sweet potato vine, barit and corn forage were eaten. Of acacia, saguing butuan, ipilipil, cogon, cacauati and tujod manok, only the leaves were eaten.

Superior palatability. Table 4 shows the average consumption and percentage palatability of plants tested with mature goats. Using the same standard of consumption to indicate superior palatability of plants as in the case of young goats, it is evident that the following plants should belong to this class, the rank being in the order listed: corn forage, Napier grass, Guinea grass, pulang puet, sweet potato vine, *Operculina turpethum*, cacauati, saguing butuan,

sugar cane tops, cogon, and ipilipil. The percentage palatability among mature goats of these plants based on corn forage as 100 per cent is as follows: Napier grass, 93.19 per cent; Guinea grass and pulang puet, each 77.45 per cent; sweet potato vine, 68.94 per cent; *Operculina turpethum*, 65.96 per cent; cacauati, 54.04 per cent; saguing butuan, 53.19 per cent; sugar cane tops, 45.53 per cent; cogon, 43.83 per cent and ipilipil, 42.98 per cent.

With these plants, the consumption by all test animals was fairly uniform except in the case of the sweet potato vine where three of the test animals apparently did not relish it. However, two of the test animals liked it exceptionally well thus bringing the average consumption of the sweet potato vine for the 5 test animals fifth in rank after corn forage. This difference in consumption of sweet potato may be due to the individual taste of the animals used.

Medium palatability. For mature goats only two forages; namely, butterfly pea and culape, were classified as of medium palatability. The percentage palatability of these plants based on corn forage consumption is 41.70 per cent with butterfly pea and 36.17 per cent with culape.

Poor palatability. Plants which were classified as poor in palatability for mature goats were aurora, aguingay, culutculutan, peanut hay, acacia, barit, *Calopogonium mucunoides*, tujod manok and dila-dila in the order named. The animals disliked dila-dila so much that only an average of .13 kgm. of it was consumed per head each time, while with the corn forage, the consumption was 18 times as much. The percentage of palatability of these plants, based on corn forage consumption is as follows: aurora, 31.91 per cent: aguingay, 31.49 per cent; culutculutan, 28.51 per cent; peanut hay, 28.09 per cent; acacia, 25.96 per cent; barit, 25.11 per cent; *Calopogonium mucunoides*, 22.13 per cent; tujod manok, 16.17 per cent; and dila-dila, 5.53 per cent.

Consulting tables 3 and 4, it may be noted that while *Operculina turpethum* appears as one of the plants poor in palatability for young goats, the same species was one of those superior in palatability for mature goats. Sugar cane tops ranked lowest among plants that were medium in palatability for young goats but was of superior palatability for adult goats. Another forage deserving attention is *Calopogonium mucunoides*. While this plant was consumed by young goats in amounts so as to be considered of medium palatability, in the case of mature goats it ranked low among plants classified under poor palatability. It is also of interest to know that while barit ranks next to corn forage in palatability for horses (Tuya, 1930), yet for goats, it ranks low under poor palatability. At the Hawaiian

Experiment Station, butterfly pea was used for green manuring and was considered as having no feeding value on account of its unpalatability for live stock (Shorey, 1906).

Proximate constituents of plants

The analyses for proximate constituents of the 22 species of plants reported in this study were performed in the Experiment Station Section of the Department of Agricultural Chemistry. The analyses of 11 of these plants were made during the period that this work was conducted; for the other 11, the analyses reported in work of others (Pepa 1927, Tuya, 1930, Soriano, 1931, Fajardo, 1931) were used.

Table 5 shows the proximate constituents of all the plants studied.

Moisture. On account of the cured form of peanut hay, it is evident that among all the forages studied its moisture content, 14.50 per cent, would be far lower than that of the succulent plants. Such forages as aurora, dila-dila, sugar cane tops, pulang puet, Napier grass, *Operculina turpethum,* sweet potato vine and butterfly pea, containing over 80 per cent of moisture, may be considered watery plants. Acacia, culutculutan, barit, aguingay and cogon having less than 70 per cent of moisture may be said to be concentrated forages. The other species; namely, ipilipil, corn forage, Guinea grass, culape, *Calopogonium mucunoides,* saguing butuan, tujod manok and cacauati having between 70 and 80 per cent moisture may be taken as an intermediate group.

Ash. Peanut hay with 8.02 per cent and barit with 7.79 per cent were very high in ash. Because of the succulent nature of barit as compared with peanut hay, the high content of ash of this forage becomes more important. Other plants that were high in ash were aguingay, Guinea grass, tujod manok, and culutculutan, the percentage ash constituent of these plants being over 3–1/2 per cent. Such plants as ipilipil, *Operculina turpethum,* aurora, sweet potato vine, cacauati, corn forage, butterfly pea and sugar cane tops showed poorly in ash content, the amount being less than 2 per cent. Other forages as Napier grass, acacia, dila-dila, *Calopogonium mucunoides,* pulang puet, saguing butuan, culape and cogon gave intermediate amounts between 2 and 3–1/2 per cent.

Crude proteins. The most nitrogenous feed analyzed was ipilipil in which the protein content amounted to 13.34 per cent. Peanut hay was next in richness as to protein content, amounting to 13.26 per cent. Forages like acacia, tujod manok, culutculutan,

Operculina turpethum, butterfly pea, cacauati, and *Calopogonium mucunoides* may be grouped together with peanut hay and ipilipil as being highly nitrogenous forages, 4 per cent or over of their constituents being in the form of crude proteins. Napier grass, culape, sugar cane tops, and sweet potato vine may be considered as poor protein feeds, there being less than 2 per cent of crude protein in them. Plants containing between 2 and 4 per cent crude proteins include aurora, pulang puet, corn forage, barit, aguingay, Guinea grass, cogon, saguing butuan and dila-dila.

Crude fiber. The most fibrous of the feeds analyzed was peanut hay, containing 18.96 per cent of this constituent. Acacia, cogon, aguingay and barit with 10 per cent may be considered as highly fibrous materials. Feeds containing less than 5 per cent fiber, include pulang puet, aurora, *Operculina turpethum*, sweet potato vine, tujod manok, dila-dila, ipilipil and cacauati. Plants containing between 5 and 10 per cent of fiber were butterfly pea, culutculutan, saguing butuan, *Calopogonium mucunoides*, corn forage, sugar cane tops, culape, Napier grass and Guinea grass.

Nitrogen-free-extract. The amount of nitrogen-free-extract in peanut hay was high, 43.57 per cent. Other plants containing over 10 per cent of this substance were aguingay, corn forage, barit, culape, cogon, culutculutan, acacia, aurora, saguing butuan and cacauati; those containing less than 5 per cent were butterfly pea, ipilipil and *Operculina turpethum*. Guinea grass, sugar cane tops, *Calopogonium mucunoides*, pulang puet, Napier grass, sweet potato vine, tujod manok and dila-dila contained an intermediate amount, that is, between 5 to 10 per cent.

Fat. Plants having one or more per cent of fat were aguingay, saguing butuan, *Calopogonium mucunoides*, peanut hay, and cogon; those containing less than 0.5 per cent of fat were Napier grass, pulang puet, aurora, *Operculina turpethum*, sweet potato vine, and dila-dila. Culutculutan, corn forage, Guinea grass, culape, sugar cane tops, barit, tujod manok, acacia, cacauati, ipilipil and butterfly pea contained an intermediate amount, between .5 and 1.0 per cent.

SUMMARY

From the results obtained in this work the following statements may be made:

1. That for young goats, because of their palatability, Guinea grass, Napier grass, pulang puet, ipilipil and saguing butuan are highly recommended for feeding purposes.

2. Because of reasonable consumption shown, culape, butterfly pea, *Calopogonium mucunoides*, culutculutan, and sugar cane tops may be used to feed young goats in the absence of more palatable plants.

3. Because of low palatability, aurora, tujod manok, *Operculina turpethum*, acacia and dila-dila, should not be, generally, considered as feed for young goats.

4. For mature goats any of the following forages of superior palatability may be used as feed: corn forage, Napier grass, Guinea grass, pulant puet, sweet potato vine, *Operculina turpethum*, cacauati, saguing butuan, sugar cane tops, cogon and ipilipil.

5. Butterfly pea and culape were consumed in moderate amounts and may therefore be fed to mature goats in the absence of more palatable feed.

6. The consumption of the following was so low that the feeding of these plants to mature goats would not be justified: aurora, aguingay, culutculutan, peanut hay, acacia, barit, *Calopogonium mucunoides*, tujod manok and dila-dila.

7. Of the plants of superior palatability for young goats, saguing butuan showed the highest in total dry matter, followed by Guinea grass, then by ipilipil. Pulang puet and Napier grass are low in dry matter. Of these, the most desirable is ipilipil which contains 13.34 per cent of crude protein; pulang puet, second in richness, contains 2.63 per cent.

8. Of the plants which were of medium palatability for young goats, culutculutan leads in the amount of dry matter it contains. Next to it is *Calopogonium mucunoides*, then culape. Both sugar cane tops and butterfly pea are more watery forages. Culutculutan is also the most desirable from the standpoint of crude protein content while *Calopogonium mucunoides* and butterfly pea, both leguminous, come next in richness in crude protein. Culape and sugar cane tops are both very low in crude protein.

9. For mature goats, among forages of superior palatability, cogon is the highest in dry matter and also in crude fiber. Guinea grass, cacauati, ipilipil and saguing butuan, come next in dry matter content. Napier grass, pulang puet, *Operculina turpethum*, sweet potato vine, sugar cane tops are more watery. From the standpoint of crude protein, ipilipil with 13.34 per cent of crude protein content, is far superior to cacauati with 5.79 per cent, the next highest in richness. *Operculina turpethum* with 4.57 per cent and saguing butuan with 3.95 per cent are also fairly rich in crude protein. Napier grass, sweet potato vine, and sugar cane tops are poorest in crude protein.

10. Between culape and butterfly pea which are of medium palatability for mature goats the culape contains a greater amount of dry matter than the butterfly pea, whereas in crude protein content the butterfly pea, being a legume, is the richer feed.

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TABLE 1

Showing breeding, sex, age and weight of experimental animals

HERD NO.	BREEDING	SEX	AGE	AV. WEIGHT DURING TRIAL
		First set		
				kgm.
257	Indian grade	Male	10 mo.	15.2
261	Indian grade	Female	10 mo.	14.3
265	Anglo-Nubian grade	Female	9 mo.	15.2
266	Anglo-Nubian grade	Female	9 mo.	14.1
269	Indian grade	Male	7 mo.	15.1
		Average	9 mo.	14.8
		Second set		
70	Indian grade	Female	7 yr., 2 mo.	38.0
78	Indian grade	Female	6 yr., 9 mo.	29.5
96	Indian grade	Female	6 yr., 3 mo.	29.9
103	Indian grade	Female	6 yr., 1 mo.	30.5
198	Anglo-Nubian grade	Male	3 yr., 3 mo.	41.2
		Average	5 yr., 11 mo.	33.8

TABLE 2

Showing the date of feeding of test plants

TEST PLANTS	YOUNG GOATS		MATURE GOATS	
	Beginning of feeding	End of feeding	Beginning of feeding	End of feeding
Guinea grass	June 28, 1930	July 7, 1931	May 24, 1931	June 2, 1931
Napier grass	Jan. 24, 1931	Feb. 2, 1931	Mar. 10, 1931	Mar. 19, 1931
Pulang puet	July 18, 1930	July, 27 1930	July 8, 1931	July 17, 1931
Culape	Oct. 11, 1930	Oct. 20, 1930	Oct. 6, 1931	Oct. 15, 1931
Tujod manok	Oct. 26, 1930	Nov. 4, 1930	Nov. 20, 1931	Nov. 29, 1931
Butterfly pea	Aug. 7, 1930	Aug. 16, 1930	Aug. 7, 1931	Aug. 16, 1931
Culutculutan	Nov. 25, 1930	Dec. 4, 1930	Sept. 6, 1931	Sept. 15, 1931
Sugar cane tops	Feb. 8, 1931	Feb. 17, 1931	Feb. 24, 1931	Mar. 5, 1931
Operculina turpethum	Sept. 11, 1930	Sept. 20, 1930	May 9, 1931	May 18, 1931
Acacia	Dec. 10, 1930	Dec. 19, 1930	April 24, 1931	May 3, 1931
Ipilipil	Jan. 9, 1931	Jan. 18, 1931	April 9, 1931	April 18, 1931
Saguing butuan	Dec. 25, 1930	Jan. 3, 1931	Mar. 25, 1931	April 3, 1931
Aurora	Aug. 27, 1930	Sept. 5, 1930	July 23, 1931	Aug. 1, 1931
Calopogonium mucunoides	Sept. 26, 1930	Oct. 5, 1930	Aug. 22, 1931	Aug. 31, 1931
Dila-dila	Nov. 10, 1930	Nov. 19, 1930	Dec. 5, 1931	Dec. 14, 1931
Cogon	....	....	June 8, 1931	June 17, 1931
Cacauati	....	....	June 23, 1931	July 2, 1931
Aguingay	....	....	Sept. 21, 1931	Sept. 30, 1931
Sweet potato vine	....	....	Oct. 21, 1931	Oct. 30, 1931
Peanut hay	....	....	Nov. 5, 1931	Nov. 14, 1931
Barit	....	....	Dec. 22, 1931	Dec. 31, 1931
Corn forage	....	....	Feb. 16, 1932	Feb. 23, 1932

TABLE 3

Showing average consumption and percentage palatability of plants tested with young goats

First set

PLANTS	ANIMAL NO.					AVERAGE CON-SUMPTION	PERCENTAGE PALATABILITY BASED ON GUINEA GRASS
	257	261	265	266	269		
	kgm.	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*	
Superior [a] *palatability*							
Guinea grass ..	1.43	1.48	1.66	1.61	1.34	1.50	100.00
Napier grass ..	1.02	1.41	2.04	.77	1.09	1.27	84.66
Pulang puet ...	1.11	1.09	1.32	1.16	1.16	1.17	78.00
Ipilipil	1.20	.93	1.61	.86	1.16	1.15	76.66
Saguing butuan	1.11	1.11	1.29	.66	.97	1.03	68.66
Medium [b] *palatability*							
Culape	.95	.95	.91	.80	.86	.89	59.33
Butterfly pea .	.95	.80	.77	.87	.86	.85	56.66
Calopogonium mucunoides .	.82	.73	.95	.77	.78	.81	54.00
Culutculutan ..	.82	.80	.80	.78	.73	.79	52.66
Sugar cane tops	.75	.80	.84	.77	.71	.77	51.33
Poor [c] *palatability*							
Aurora	.73	.68	.68	.77	.52	.68	45.33
Tujod manok .	.46	.50	.50	.50	.53	.50	33.33
Operculina turpethum ..	.43	.50	.30	.36	.50	.42	28.00
Acacia	.34	.22	.47	.36	.11	.30	20.00
Dila-dila	.18	.25	.25	.18	.16	.20	13.33

[a] Superior palatability applies to feeds of which an average of over one kilogram per head was consumed.

[b] Medium palatability refers to feeds the consumption of which amounted to an average of from .76 to 1 kilogram each goat.

[c] Poor palatability applies to feeds of which an average of .75 kilogram or less per animal was consumed.

TABLE 4

Showing average consumption and percentage palatability of plants tested with adult goats

Second set

PLANTS	ANIMAL NO.					AVERAGE CONSUMPTION	PERCENTAGE PALATABILITY BASED ON CORN FORAGE
	198	70	78	96	103		
	kgm.	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*	
Superior [a] *palatability*							
Corn forage ..	41.11	2.04	1.79	2.13	1.67	2.35	100.00
Napier grass ..	2.04	1.45	3.35	2.84	1.27	2.19	93.19
Guinea grass ..	2.72	1.36	1.82	1.84	1.34	1.82	77.45
Pulang puet ..	1.75	2.,00	1.52	1.70	2.13	1.82	77.45
Sweet potato vine	.59	.47	3.68	2.89	.45	1.62	68.94
Operculina turpethum ..	1.81	1.54	1.93	1.82	.64	1.55	65.96
Cacauati	1.66	1.07	1.02	1.36	1.25	1.27	54.04
Saguing butuan	1.50	.91	1.59	1.36	.91	1.25	53.19
Sugar cane tops	1.15	.80	1.34	1.51	.57	1.07	45.53
Cogon	1.50	1.04	.86	.97	.79	1.03	43.83
Ipilipil	.95	1.04	1.18	1.07	.82	1.01	42.98
Medium [b] *palatability*							
Butterfly pea .	.59	1.22	.77	1.02	1.32	.98	41.70
Culape	.36	.31	1.70	1.54	.34	.85	36.17
Poor [c] *palatability*							
Aurora	.36	1.00	.39	.43	1.57	.75	31.91
Aguingay	.61	.45	1.29	.95	.40	.74	31.49
Culutculutan ..	.56	.54	.84	1.02	.40	.67	28.51
Peanut hay ...	.61	.72	.65	.72	.58	.66	28.09
Acacia	1.13	.73	.46	.43	.32	.61	25.96
Barit	.66	.74	.49	.61	.44	.59	25.11
Calopogonium mucunoides .	.22	.29	1.09	.72	.29	.52	22.13
Tujod manok ..	.18	.27	.58	.58	.27	.38	16.17
Dila-dila	.15	.13	.15	.09	.11	.13	5.53

[a] Superior palatability applies to feeds which were consumed on an average of over one kilogram per head.

[b] Medium palatability refers to feeds the consumption of which amounted to an average of from .76 to 1.00 kilogram each goat.

[c] Poor palatability applies to feeds of which an average of .75 kilogram or less per animal was consumed.

TABLE 5

Showing average proximate analysis of plants used in the experiment

PLANTS	NUMBER OF SAMPLES	MOISTURE	ASH	CRUDE PROTEIN	CRUDE FIBER	NITROGEN FREE EXTRACT	FAT
		per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
Guinea grass	18	75.95	3.92	2.33	7.79	9.41	.65
Napier grass	7	83.15	2.64	1.37	5.56	6.79	.46
Pulang puet	1	82.17	2.71	2.63	4.77	7.45	.27
Culape	4	76.12	3.10	1.78	6.96	11.38	.68
Cogon	5	66.28	3.07	2.18	12.14	15.33	1.00
Aguingay	3	61.46	4.96	2.09	12.24	17.51	1.71
Sugar cane tops ...	3	81.07	1.85	1.17	6.27	9.14	.84
Barit	3	62.35	7.79	2.54	10.46	16.33	.54
Corn forage	6	70.38	1.83	3.40	6.94	17.12	.70
Butterfly pea	1	83.22	1.83	4.00	6.10	4.16	.69
Calopogonium mucunoides	1	75.47	2.03	4.88	7.82	8.68	1.12
Peanut hay	1	14.50	8.02	13.26	18.96	43.57	1.69
Aurora	1	80.38	1.77	3.41	3.66	10.32	.46
Operculina turpethum	1	87.98	1.41	4.57	2.90	2.77	.37
Sweet potato vine .	1	84.81	1.84	1.96	2.72	8.41	.28
Saguing butuan ...	1	74.40	3.17	3.95	6.78	10.06	1.64
Culutculutan	1	65.85	3.70	6.03	7.10	16.36	.96
Tujod manok	1	78.31	4.17	6.10	3.32	7.55	.55
Dila-dila	1	81.89	2.88	3.00	3.78	8.25	.20
Ipilipil	1	78.18	1.68	13.34	3.22	2.93	.65
Acacia	1	58.12	2.53	10.76	13.81	13.93	.85
Cacauati	1	77.73	1.90	5.79	3.57	10.20	.81

NOTE: ROME AND AGRICULTURE

This is Rome, Italy, not any of its unsung namesakes.

The World Poultry Congress

In September of this year the Fifth World Poultry Congress meets in Rome of the Seven Hills.

Rome and a poultry exhibition! Rome and the Coliseum, Hadrian's Tomb, the excavated palaces of the Caesars, the Pantheon; Rome of processions celebrating victories with Zenobias chained to the triumphal car. But Rome as a meeting place for the world's poultrymen! One is not exactly startled, but certainly interested.

But there is a link between Rome and poultry. One morn, long, long ago, so the legend goes, sleepy Roman sentinels were roused by the cackling of faithful patriotic geese and Rome was saved.

That the Fifth World Poultry Congress will be successful there is little doubt. National committees in twenty or more countries are making preparations for participating in the congress and the exhibit. The Italian Committee is doing its utmost to make all arrangements for meetings of the congress and care of the delegates. The Exhibition will be held in Trajan's Markets where, "Each stone of the majestic building seems to tell of the greatness of Rome and the splendor of its history." Arrangements are being perfected for the delegates to see the famed buildings and parts of buildings that tell of old Rome, and her treasures of art will be thrown open. Also, excursions are being planned "to give visitors the chance of seeing the improvements made in Italy in agriculture in general and especially in poultry breeding. After the Congress an extensive tour through a great part of central and northern Italy will afford the members of the Congress an opportunity to visit the most important poultry breeding regions, and to see something of Italian scenery and old and modern towns, such as Leghorn, Florence, Bologna, Venice, Milan etc."

Fortunate, fortunate delegates!

The International Yearbook of Agricultural Statistics

The International Institute of Agriculture which is in Rome, "by the yellow Tiber," the Father Tiber that tosses its "tawny mane," has recently published the 1931-32 edition of the *International Yearbook of Agricultural Statistics.*

All who are interested in questions related to production and distribution of agricultural products will find this volume of 800 pages valuable. It is the result of wide investigation in international agricultural statistics.

This yearbook is divided into three parts. The carefully compiled figures on area and population in the first part "reveal the situation from the geographical, political and demographical point of view" in 208 countries in the post-war period. The second part in a series of tables gives data for about 50 countries on the uses for which the total area is used. The third part gives tabulated data for 40 agricultural products. The area, production and yield per acre in each of the 50 countries are given for 1923-1927 and for each year from 1928 to 1931.

ABSTRACT [1]

Some clarification characteristics of cane juice. WENCESLAO N. TINGSON. (*Thesis presented for graduation, 1931, with the degree of Bachelor of Science in Sugar Technology from the College of Agriculture No. 354; Experiment Station contribution No. 897.*) —The author worked out a method of removing non-sugar substances, either in solution or in suspension, with the least destruction of glucose in the juice during clarification. He prepared 10 samples of 1600 cc. each of mixed juice of sugar cane. One sample he used as control; the rest, he treated with different quantities of 14 Brix lime solution giving different pH values. In series 1, the pH values ranged from 5.5 to 9.8; series 2, from 5.8 to 11.8; series 3, from 5.4 to 9.9. This treatment was termed *toward alkalinity*. From the same mixed juice one sample, 1600 cc., was taken as control and another portion was heavily limed, from which 9 samples of 1600 cc. were prepared. The 9 samples were treated with different quantities of acetic acid c.p. The pH values in series 1 ranged from 4.8 to 9.8; series 2, from 5.6 to 9.9; series 3, from 5.2 to 9.4. This treatment was termed *back to acidity*. The treated samples were then heated to boiling for 6 to 7 minutes; allowed to stand to obtain clear juice; and decanted. Determinations for pH values; percentage of glucose, P_2O_5, SO_4 ash, CaO, SiO_2 Al_2O_3, Fe_2O_3 and MgO; and conductivity were made.

[1] Abstract prepared as part of required work in English 3a, College of Agriculture.

Mixed juice from the Calamba Sugar Estate and crusher juice from the College seedling canes were used in this work.

The following results were obtained by the author:

1. In the treatment *toward alkalinity*, an increased treatment of lime—which correspondingly increased the pH of the solution—increased the CaO in solution in the clarified juice, and the removal by precipitation of inorganic substances, as P_2O_5, SO_4, Al_2O_3, Fe_2O_3 and MgO also increased.

The maximum increase of purity from mixed juice to clarified juice reached a limit at certain pH. Further addition of lime did not bring any increase in purity. The Calamba Sugar Estate mixed juice attained the maximum purity for series 1 of 85.34 per cent at pH 8.7 giving an increase of 4.16 per cent over the control the pH value of which was 5.5, and for series 2 of 87.94 per cent at pH 10.1 giving an increase of 3.7 per cent over the control whose pH value was 5.8. However, the percentage of glucose destroyed was 33.57 for series 1 and 27.4 for series 2. At pH 6.3 in series 1, the purity was 84.33 per cent, or an increase of 3.15 per cent over the control; the percentage of glucose destroyed was the minimum, 7.98 per cent. In series 2, at pH 7.7 the purity was 86.92 per cent, or an increase of 2.68 per cent; the glucose destroyed was 7.18 per cent. The College crusher juice reached a maximum purity of 86.94 per cent at pH 9.3 giving an increase of 0.74 per cent over the control. The percentage of glucose destroyed was 25.65. At pH 7.5, the purity was 86.58 per cent, or an increase of 0.38 per cent; glucose destroyed was 5.16 per cent.

2. When the mixed and crusher juices were limed heavily to the highest pH, the percentages of the inorganic impurities were at minimum; the percentages were lower than those of the control. The addition of the acetic acid brought back into solution the precipitated inorganic substances. It also increased the amount of lime going into solution. The attendant effect of the lime and the impurities going into solution was the lowering of the purity; hence, the ash of the treatment *back to acidity* increased from the highest pH values to low pH value.

3. Results of the tests showed that clarification had little effect upon conductivity.

—*Abstract by J. P. Mamisao*

CURRENT NOTES

The prediction by Dr. Sven Hedin, Swedish explorer of Central Asia, that in 25 years the River Tarim in Chinese Turkestan would abandon its course and return to an ancient channel farther north has now been fulfilled, according to a communication received at Washington. The river is running now where it did 1,600 years ago. Dr. Hedin's attention was called to the wandering stream when he tried, to follow a Chinese map 1,600 years old. It appeared that the Chinese geographers had made a mistake, for the river on the map was not on the landscape, but instead there was a "new" river to cross 550 miles away. After studying geological conditions, Dr. Hedin justified the Chinese scholars and their map by explaining that the southern branch of the Tarim apparently swings back and forth like a pendulum. He predicted then that the accumulating silt would soon drive the river to seek its old course.

Science

The principal constituent of plants—*carbon*—comprising as it does about 45 per cent. of the matter of plants, is obtained from the air.

Oxygen, of which plants contain nearly as much as they do of carbon, is obtained mainly from water and air, and to a lesser extent in combination with other substances.

Hydrogen, which comprises about 6 per cent of plants, is secured mainly from water.

Nitrogen is collected from the air, stored up in the soil, and is taken by plants through their roots.

The *mineral matters*, which are the other materials used by plants to build up their substance, are all secured from the soil.

The Journal of the Department of Agriculture of South Australia, February 15, 1933

A new nail chemically pitted to give a greater gripping power is estimated to be two or three times stronger in holding power than the common nail.

Iowa Agriculturist, March, 1933

Recent work at the University College of Science, Calcutta, has been carried out in an endeavor to synthesize a compound which might replace quinine, the production costs of which are very heavy.

It is now reported that Professor H. K. Sen and Professor W. Basu have obtained a substance in the laboratory which on testing has been found to be a good substitute for quinine. Whilst having the same antiparasitic value, it has the advantage of not producing the side effects associated with quinine, and the taste in water is not so bitter. The compound is an ammonium salt obtained in work on coal tar derivatives, and it is stated to be moderately soluble in water. (*Chem. and Ind.*, Vol. II., 1932, No. 43, p. 884)

Reprinted in *Tropical Agriculture*, February, 1933

A leading American wholesale dealer in bananas, whilst recently visiting the Tweed district, stressed the careful attention given in his country to every detail to preserve the appearance of the fruit, so that it should be perfectly free from all blemishes, such as characterized bananas he had seen in Sydney. He held that a great deal more attention should be paid in this country to every operation, from the cutting of the fruit until its delivery in the retail shop. In America, he added, bananas were handled as carefully as though they were eggs.

The Australian Sugar Journal, April 6, 1933

In these days when surplus stocks of sugar, coffee and other crops that cannot be stored in silos, have to be kept in good order for many months, and perhaps several years, can it be claimed that the soft-fibred jute is the ideal covering for such segregated stocks? The produce must be kept cool and dry, or as near so as possible. Can this be obtained as effectually and cheaply with jute as the covering as with sisal? Marked, and especially rapid, changes of temperature, must be avoided and the chances of sweating reduced to a minimum. Above all, which material, jute or sisal, will prove to give the greatest facility when handling the huge stocks that have to be tended and moved, and which fibre would give the best ventilation during storage. Surely, after various experiments, perhaps a mistake or two, we shall find that sisal will answer the purpose best?

Tropical Life (London) March, 1933

Etch surface of concrete to roughen it with muriatic or commercial hydrochloric acid. Dilute 1 part acid to 5 parts water. Apply acid to floor surface and allow to remain until desired amount of

roughness occurs. Then remove by thoroughly washing with water to prevent further action. A second treatment may be given if desired. Sprinkling ordinary ground limestone over the floor after cleansing also tends to prevent slipping.

Queensland Agricultural Journal, April, 1933

This disease [bud rot] if Coconuts was responsible for the loss of nearly 100,000 coconut trees after 1903's hurricane. The reason for this was that the diseased trees had been neglected before the hurricane and left rotting in the fields. When the hurricane came along and damaged hundreds of thousands of trees, the broken surfaces of the heart leaves became danger points for infection.

After the drastic destruction of all infected trees and their burning up under guidance of the Plant Disease Inspectors the disease almost ceased to exist and for years now the cases have been rare.

There appears now however to be a gradually increasing incidence of cases showing up. All coconut growers should at once see that all cases are cut down and burnt thoroughly now. Otherwise the same thing as happened after the 1903 hurricane will happen again.

This warning is needed as it is quite certain it cannot be expected that Jamaica will indefinitely be free of hurricane.

The Journal of the Jamaica Agricultural Society, June, 1931.

COLLEGE AND ALUMNI NOTES

Dean B. M. Gonzalez was the principal speaker at the graduation exercises of the Indang Rural High School, April 1, 1933.

Dr. Miguel Manresa was the principal speaker at the graduation exercises of the Odiongan Rural High School, April 6, 1933. His theme was "Industries in Agriculture."

On June 1, Robert L. Pendleton returned from an extended leave of absence in China, to resume headship of the Department of Soils. For the greater part of the last two years Professor Pendleton has held the position of Chief Soil Technologist to the National Geological Survey. With headquarters at Peking, he has been responsible for the development of a soil survey for China. His

studies there included the training of a field survey staff, the erection and equipment of a soils laboratory, and the publication of the results of soil research. Considerable progress has already been made in the mapping of typical soil areas in widely scattered parts of China, and also in encouraging coöperation between the various official, educational, missionary, and commercial organizations which are actively carrying on in some form soil research.

On May 7, 1933, Mr. Engracio Basio gave a talk on poultry problems before an assembly of "tenientes del barrio" of the municipality of San Pablo, Laguna.

In the meeting of the Society for the Advancement of Research held March 23, 1933 the following members were elected officers for the academic year 1933-1934.

President	Dr. G. O. Ocfemia
Vice-President	Dr. Miguel Manresa
Secretary	Dr. F. M. Fronda
Treasurer	Dr. Leon G. Gonzalez

After serving as secretary for a term of three years Doctor Fronda was re-elected for another three years.

The Department of Agricultural Engineering is carrying on some interesting field extension work on engine fuels. This work, made possible by the coöperation and generosity of manufacturers of and dealers in engines and fuels and the Calamba Sugar Estate, is of much practical value. Some idea of the work is given in the following paragraphs.

The Department of Agricultural Engineering has just returned to the International Harvester Company of Philippines, a 40 h. p. stationary unit which was loaned to the department for research studies. The engine was equipped with three sets of high compression pistons. Experiments were conducted for almost a year using as fuels, kerosene, mixtures of kerosene and crude oil in various proportions, alcohol-gasoline combination, alcohol-kerosene-ether combination, alcohol-benzol-gasoline combination, and nearly straight alcohol. Most of the fuels and oils were supplied by the Asiatic Petroleum Company, La Tondeña, Socony-Vacuum Company, Central Azucarrera de Tarlac, and the Kavankalan Sugar Company.

The Department has recently received a model XAH four-cylinder engine 3-5/8" × 4-1/2" from the Waukesha Motor Company, Waukesha, Wisconsin, U. S. A. The Company furnished the engine at no charge to the College except the transportation from the United States to the Islands. As an accessory to the engine was included a high compression head for research work in alcohol. Some of the accessories necessary to set the engine for bench tests were provided by the Calamba Sugar Estate and the International Harvester Company of Philippines. The Department has also received for research purposes a 1929 Model A Ford Engine from the Manila Trading Company.

The Department in coöperation with the Calamba Sugar Estate is carrying on very extensive research studies on the use of different grades of alcohol and gasoline as fuels. The work began January 1, 1933. Field tests on Chevrolet trucks which are used for cane hauling are completed. From 1000 to over 2000 km. of travel were covered by each truck using special alcohol motor fuel, dehydrated alcohol, and gasoline as fuels. Engine wear, carbon formation, fuel and oil consumption, oil dilution, corrosion, valve sticking, ease of starting, and general engine behavior were a few of the objects sought in the tests. Laboratory tests were also made in the department, using as additional fuels, different grades of alcohol from 94 per cent to 99.6 per cent by volume. With more controlled apparatus, it was possible to accurately run the engines on the bench with variable speeds, loads, throttle opening, and different sizes of carburetor jets best suited for the special kinds of fuel used.

At present, tests are being made using a high compression Waukesha four-cylinder engine as motive power. The crank case is supplied with a special Wakefield Castrol oil (with castor oil as base). The same kind of engine is now used by the International Harvester Company for one of the types of trucks which they handle. The laboratory tests are made under the supervision of some of the members of the staff of the Department of Agricultural Engineering in coöperation with representatives from the Calamba Sugar Estate, International Harvester Company, and Wise & Company.

In the interest of their work in the College, Dr. F. M. Fronda of the Department of Animal Husbandry, Mr. Joaquin Ruiz de Arana of Service Division, Mr. Vicente M. Dawis and Mr. Moises Villaluz

of the Department of Agronomy went to Baguio on May 19 returning on May 22. Doctor Fronda was especially interested in observing the adaptation of temperate zone breeds of poultry to Baguio conditions, with an idea that this locality might be used as a sort of "introduction garden" in the gradual acclimatization of such breeds to Philippine conditions. Mr. Arana looked into the problems of road construction, especially as to ways and means of overcoming slopes, and the proper drainage of roads on inclines, and the surfacing of roads with sharp grades. He also studied the methods followed in the construction of buildings on very sharply sloping locations, and using such locations to advantage. Messrs. Dawis and Villaluz looked into problems of landscape gardening and architecture with a view to getting ideas for possible use on the Campus and beautification of similar situations elsewhere.

The ninth graduation exercises of the extension course in the College of Agriculture given in the Summer School were held on May 20. This year, 51 students were enrolled and 48 certificates were awarded. Forty-two of these certificates were in Poultry Raising and six in Propagation of Tropical fruit Plants. Four of the certificates were awarded to women.

Of the 51 students enrolled in the extension courses this year, 14 were under 20 years old, 28 were between 20 and 29 years, 5 were between 30 and 39, and 4 were between 40 and 43 years old. These students were distributed in the following occupations: 20 students, 13 teachers, 6 farmers, 5 poultry raisers, 4 merchants, 1 fisherman, 1 dentist and 1 clerk. There were 19 provinces represented. The provinces that had three or more representatives were: Batangas, Bulacan, Cavite, Laguna, Manila, Pampanga, Occidental Negros, Rizal and Tarlac.

About ten years ago the old silk house and the old green house, near Molawin Creek, were "remodeled" into a single building to house the then newly established Division of Soils of the Department of Agronomy. During May of this year the now separate Department of Soils was assigned the old veterinary building northwest of the main campus entrance, and in these new quarters the department is now housed.

After calling the second story of the Old College Building home for ten years, the Department of English on June 3 moved down the street a few rods into the second story of the building formerly occupied by the Department of Soils.

The opening convocation was held in the Auditorium at eight o'clock on June 6. Dr. Miguel Manresa, Chairman of the Committee in Social Affairs, presided. Dean Gonzalez addressed the student body. The yells and singing of college songs went off with a snap under the leadership of Antonio Flores, Miguel Alba and Abel Silva.

Jose Utzurrum, President of the Student Body, and Rafael Roces, Jr. President of Junior Class gave vivid talks on the life of the students in the College. The talks showed that these young men saw the life quite fully and understandingly.

Mr. Conrado B. Uichanco, B.S.A. '33 is now Editor of *The Philippine Poultry Journal*, succeeding Dr. F. M. Fronda, who was the founder and the first editor of this Journal. Heavy work in the College of Agriculture, compelled Doctor Fronda to withdraw from this editorial work.

Miss Elena Caguicla B.Agr. '32, B.S. '33 is now employed in the chemistry division, Bureau of Science.

WILLIAM ARNON HENRY, WISCONSIN PIONEER

In this College no book is more frequently cited than *Feeds and Feeding* by Henry and Morrison. On our faculty are several men who were graduate students in the University of Wisconsin and some who had courses under Professor Morrison before he resigned to accept the directorship of the New York Experiment Station at Geneva and professorship in animal husbandry in Cornell University.

The oft-quoted *Feeds and Feeding* has had a notable life or shall we say, career. It started out as a handbook written by Professor Henry for use in his classes; was enlarged with Professor F. B. Morrison as joint author and published in 1898. In 1910, after nine editions had come from the press it was rewritten and enlarged, and ran through five editions in the next five years; was rewritten again in 1915, and the seventeenth edition was reprinted eight times between 1918 and 1921. The eighteenth edition, revised and illustrated, was published in 1922. The nineteenth edition, rewritten by Professor Morrison was published in 1928. It was translated into Portuguese in 1907 for use in Brazil and in 1912 into Russian. In response to an insistent demand for a briefer edition, Professor Morrison with editorial aid of Professor Henry, prepared an abridged edition of the eighteenth edition. This book was published in 1917. The latest edition on our campus is the sixth, published in 1929.

Because of our friendly contact with these two men, especially through *Feeds and Feeding*, and because of the value, personally and professionally, of knowing of the life work of men of worth and of deeds, the editorial on Dean Henry which appeared in the *United States Department of Agriculture Experiment Station Record* of April, 1933 is here reprinted. (EDITOR'S NOTE.)

Although more than a quarter century has elapsed since the retirement of Dean and Director W. A. Henry, his death at San Diego, California on November 24, 1932, readily brings to mind his unique and timely service for agricultural education and research. The story of the upbuilding of the agricultural work of the University of Wisconsin under his guidance has often been told, and his success in gaining for the cause the confidence and support of farm people has been widely recognized as far-reaching in its influence. Nor has the passing of the years obscured the significance of what he did, but has rather brought into even clearer perspective his substantial contribution to the agricultural colleges and experiment stations at a critical stage in their history.

Dean Henry himself said truly upon retiring in 1907 that his work had been that of a pioneer. Virtually it began in 1880 with his

appointment as professor of botany and agriculture in the University of Wisconsin. He was then 30 years of age, a graduate the preceding spring from Cornell University and with several years of teaching experience in high schools of Indiana and Colorado.

At Wisconsin he soon discovered that although a professor of agriculture had been provided as early as 1868, his department had "no offices and no laboratories; there were no workers in research, no special faculty, and no students." Most discouraging of all, there was little interest in his subject either within the institution or in the State at large.

Opportunity was open for a limited amount of experimental work, however, and in 1882, when provision was made by the State legislature for an experiment station, Prof. Henry became head of this station and continued in this capacity until his retirement. Speaking of this phase of his activities, Dr. E. W. Allen said editorially in these columns in 1907, "he had a thorough appreciation of scientific work and was keenly alive to the needs of the farmer. Step by step he developed different departments of the work, gathering around him a competent corps of workers, who were inspired by his enthusiasm and aided by his intelligent insight into the practical and scientific bearing of their work. Under his direction the Wisconsin Station has placed to its credit some of the most noteworthy contributions to the science of agriculture, and a multitude of results of practical importance which the institution has carried directly to the farmer".

Despite the efforts of Prof. Henry and his colleagues, interest in collegiate instruction continued to languish through the early eighties. Nevertheless, to quote Dr. Allen again, "he believed in agricultural education and was determined to see its value recognized. If this could not be accomplished under the conventional method of teaching, he was ready to develop and test a new plan, and he had the courage of conviction necessary to carry it out in the face of doubt, if not opposition. And so he organized in 1886 the first successful short course in agriculture in this country; and when its success had been demonstrated he established the first dairy school in America in 1890. Four years later he started the 10-day course for adult farmers, which attracted 175 men the first year and was attended (in 1907) by 607 farmers."

These educational experiments, for such they may be termed, were closely observed and eventually adopted by other institutions, many of which had been facing similar conditions. As Professor

Emeritus C. S. Plumb of Ohio State University, virtually a contemporary in the field, has recently said, "all over the country the colleges became interested in the Wisconsin work, and vocational courses and laboratory work in dairying and judging farm animals were the entering wedges of a new agriculture .... This vocational phase of agricultural instruction was the salvation of agricultural education in North America."

Aside from the intrinsic value of the short courses, they proved of even greater service by their stimulation of more advanced instruction. Attendance in four-year courses picked up, and even graduate work was soon demanded. Organization of a college of agriculture became possible in Wisconsin in 1891, with Prof. Henry serving as dean until his retirement. At that time its enrollment was in excess of 600 students, and its buildings and equipment had become notable as among the best of their kind.

Although Dr. Henry's institutional service for agriculture is associated exclusively with Wisconsin, he was soon widely known and greatly esteemed beyond its borders. One extensive point of contact was the comprehensive manual entitled Feeds and Feeding, first published by him in 1898 and since familiar to every student of animal nutrition. His portrait constituted the first contribution to a gallery of men conspicuous for their service to the livestock industry, started in 1902 in Chicago under the auspices of the International Livestock Exposition. Thrice was he recipient of the honorary doctor's degree, from the Universities of Illinois and Vermont in 1904 and the Michigan State Agricultural College in 1907.

Dr. Henry was long an outstanding figure in the Association of American Agricultural Colleges and Experiment Stations, now the Association of Land-Grant Colleges and Universities. He represented the State of Wisconsin in the first convention of this body, held in 1887, was chosen a member of its executive committee the following year, and in 1893 achieved the honor of being the first experiment station director to occupy the presidency. Subsequently he was unfailing in attendance, indefatigable in committee service, and the sponsor of an unusual number of worthy projects.

In 1888 he argued for close contacts by the colleges and stations with farmers, opened a discussion of how the Federal Department of Agriculture could assist the stations by drawing special attention to the opportunity for centralized bibliographical work and the compilation of material from a broad national viewpoint, and pleaded for

inclusion in the association's membership of the staff members as well as the administrative heads. He early advocated the abstracting by the Office of Experiment Stations of European investigations as well as those in this country, and took a prominent part in arranging active station participation in the World's Columbian Exposition at Chicago and later expositions elsewhere. In 1901 he secured the passage of a resolution favoring more adequate accommodations for the Department of Agriculture, and for several years he served on a committee to promote coöperative relations with the Department. He introduced a resolution in 1900 and again in 1901 to the effect that directors and department heads of experiment stations should, if possible, devote their whole time to the work of investigation, and while this resolution was subsequently withdrawn, the discussion was doubtless beneficial. He obtained a reorganization of the association itself whereby a section of experiment station work was set up in 1903. Many other items in the record attest the breadth of his interest and his prestige among his colleagues.

Special mention should be made of his presidential address, delivered on October 17, 1893. In this he reviewed the passage of the Hatch Act and the developments under its provisions during the intervening six years, and stated that "the more I study the work of our experiment stations, the more I am pleased with what we have accomplished and the larger grows my faith in the high position they are destined to occupy in American Agriculture." Nevertheless, he stated rather bluntly that in his opinion serious mistakes had been made. Among the outstanding needs he cited the more careful planning of work, greater continuity, concentration upon no more projects than could be adequately maintained, greater coöperation between stations, and especially a clearer demarcation and differentiation between teaching and research.

Dr. Henry's interest in improving the quality of the station research continued to develop with the years, and in 1906 many of his ideals found fruition in the passage of the Adams Act. Beginning with a conference with Mr. Adams in 1903, he had a large share in the initiation and drafting of this legislation. It was largely because of the stress which he and others laid on the need for the more fundamental investigations that the funds provided by the act were restricted "to paying the necessary expense of conducting original researches or experiments bearing directly on the agricultural industry of the United States."

The final address of Dr. Henry before the association was given November 15, 1906, entitled The Agricultural College and the State: A Plea for a New Division of College and Station Workers, this address logically supplemented his previous pleas for a station staff freed as largely as possible from the distractions and burdens of other duties. "As a remedy for the present unsatisfactory situation," he said, "I suggest that there be organized in every college and station a separate corps of workers whose sole duty shall be to serve as intermediaries between the college and station on the one hand and our great farm clientage on the other. They will relieve the investigators and teachers of a large portion of their present extra college and station duties. High-grade research and the best quality of classroom instruction will then, and only then, be possible. With this corps of specially trained middlemen our colleges and stations will serve the farmers far better than is now possible." By this advocacy of an extension force nearly a decade before the Smith-Lever Act, Dr. Henry showed himself to the end consistently the pioneer.

The 27 years during which Dr. Henry did his principal work for agricultural education and research covered a period of much responsibility for the leaders in this field. There was serious danger on the one hand that the colleges and stations would fail to gain and hold the confidence of farm people, and that on the other the achievement of popularity would impair the depth and soundness of their work by a dissipation of energies in meeting immediate demands. Dr. Henry saw both these dangers and how to combat them. That these institutions find themselves to-day so firmly intrenched in public esteem seems due in no small degree to his practical common sense, his initiative and resourcefulness, and, above all, to his appreciation of and insistence upon high ideals.

Let it please you to keep in order a moderate-sized farm, that so thy garners may be full of fruits in their season.—HESIOD.

Farmers are actually becoming "soil conscious." They are recognizing that the soil is their one great asset and the basis of all their operations, of their success or of their failure. All people are coming to a realization that the soil is the national resource of the land which must be conserved to permit of a future agriculture, a future adequate production of good for the human race!

P. E. BROWN.

Pep without purpose is piffle. *Penn. State Farmer.*

A REPORT ON A RICE INBREEDING EXPERIMENT IN THE COLLEGE OF AGRICULTURE [1]

TORIBIO MERCADO AND PEDRO JUACHON

WITH THREE TEXT FIGURES

This paper describes the method followed in inbreeding rice in the College of Agriculture, University of the Philippines, and records the progress and important results that have been obtained up to 1933. The experiment was planned by Dr. N. B. Mendiola in 1927 while he was on research investigation work in Java where he found inbreeding on rice was being carried on.

The writers found no literature on rice inbreeding in the Philippines or in any other rice growing tropical country. However, Dr. N. B. Mendiola of this College, in a paper entitled "Natural crossing in rice and its relation to rice improvement" [2] makes the statement, that although the rice flower is adapted to self-fertilization several cases of natural rice hybrids are found. Because of this, a certain amount of heterozygosity exists and by the inbreeding of these heterozygous plants different strains may be produced and the best of these isolated by selection.

OBJECTS OF THE PRESENT WORK

The objects of this work were: (*a*) To record observations on the effects of self-pollination in Hambas variety of rice; (*b*) to isolate desirable strains which might be produced by inbreeding, and (*c*) to compare these selected strains with their mother variety.

TIME AND PLACE OF THE WORK

This work was performed from July, 1927 to March, 1933. All cultures which covered six successive yearly plantings were made in the Experiment Station Grounds, College of Agriculture, University of the Philippines, Los Baños, Laguna.

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[1] Experiment Station contribution No. 898. Prepared in the Department of Agronomy under the direction of Dr. N. B. Mendiola. Read in part before the Los Baños Biological Club, September 24, 1931. Received for publication May 4, 1933.

[2] MENDIOLA, N. B. 1926. Natural crossing in rice and its relation to rice improvement. Proceedings of the Third Pan-Pacific Science Congress. Tokyo, 1171-1178.

MATERIALS AND METHODS

Variety used

After deliberation it was decided to use the Hambas variety of rice as it is grown commercially in the College and in rice fields in the locality and is a good yielder, possesses excellent cooking quality, and commands a good price. Hambas is a lowland variety.

Preparation of the field and seed bed

The practice of the rice growers in Los Baños was followed in preparing the paddies for this work. For water, rain and a small irrigation system were depended upon. The paddies were plowed once and then harrowed six to seven times or until all the weeds were buried in the mud and the soil was made uniformly soft.

Different plantings made

The original stock of seedlings was obtained from one of the College rice tenants. The initial planting was made in 1927 and consisted of 1,216 individuals from which 50 plants were selected and bagged. Seeds from these 50 plants were sown in line culture. From this sowing, 1,921 seedlings were set in paddies in 1928 and another 50 plants were inbred, one plant being taken from each line. Seeds from these 50 inbred plants were sown in 1929 and from this sowing 2,134 plants were transplanted. From this planting, 57 promising strains were selected in 1930. In the next season these 57 strains were compared with their mother variety. Twenty-four strains which gave a better yield per plant than their mother variety were selected in 1931 for the next trial planting. A comparative test of the twenty-four selected strains and their parent variety was made in 1931; the grain was harvested in February, 1932. The three strains which yielded more than the control variety were saved for the next planting. During the 1932-1933 season these three strains were again compared with the parent variety. Two strains were finally selected.

In the first, second and third generations the seedlings were transplanted one plant to the hill and distanced one meter each way. The object of this distance of planting was to give space to encourage the full development of individual plants to maturity.

In comparative tests the seedlings belonging to one strain were transplanted at a distance of 20 to 25 cm. each way. Two to four seedlings were placed in a hill.

Numbering the seedlings

The original stock seedlings were numbered from 1 to 1,216, consecutively. Each seedling represented a single strain.

At the second planting the seedlings were numbered according to the original strain number and the plant number in the strain. For example, in strain No. 908-16, 908 indicated the original strain number and 16 indicated the plant number in the strain under test.

At the third planting each selected strain consisted of three numbers, the first two numbers represented the strain previously selected and the third number represented the number of the plant in that strain. At the fourth planting four numbers were used, the first three numbers represented the strain previously selected and the fourth number represented the number of the plant in the strain under test in the fourth generation culture.

Fig. 1.—A rice inbreeding field showing bags on the selected strains.

The parent seedlings were numbered thus, C_1-1; C_1-2; C_1-3; etc. *C* means check and the last serial numbers, 1, 2, 3, etc. represent the plant numbers in each check. For check 2, C_2 is used; for check 3, C_3; for check 4, C_4; etc. From 30 to 40 plants were grown to represent each strain.

Bagging

For bagging, a cage made of a bamboo frame covered with cloth was used. The frame was 90 centimeters high and 45 centimeters in diameter. Each cage was tied to a pole. Before the appearance of the flowers, the healthy, uniform and most vigorous individuals were selected and bagged. In bagging, the cage was placed at a height that would permit the plants in the cage to grow without injury. (See fig. 1.) Each cage was held in place by sticking the end

of the supporting pole about 30 cm. into the ground. Prolonged bagging encouraged the development of the tillers; few bearing culms developed and maturity was very irregular. The reason for this was that the inbred plants were kept in the cage until maturity. The bag should have been removed a week after the majority of the inbred grains had been pollinated.

Care of the seeds and seedlings

The seeds produced from each selected inbred strain were placed in paper bags. Care was taken not to mix the seeds of one strain with those of another. The pedigree number of the strain was written on the bag and the label was placed inside of it.

To protect the seeds from rats, birds, etc., they were placed on a shelf enclosed with wire netting.

Two weeks after the seedlings were set in paddies the missing hills were replanted. All the plants in each season culture were given the same treatment. To minimize the shattering of the grains the heads were handled carefully in harvesting and in hauling them to the Plant Breeding Laboratory.

Characters studied

During the first and second plantings the same agronomic characters were noted. These characters were number of bearing and non-bearing culms; relative proportion of completely filled, almost filled, half filled, partly filled, and empty panicles per stool; yield of the inbred strains, and of the check; and presence of red and white cuticled grains.

The plants were studied in the laboratory. The number of bearing and non-bearing culms was determined by separating the non-bearing culms from the bearing ones in one plant. A culm is considered non-bearing when it does not produce flowers. Some plants reached the booting stage but no flowers came out, hence they were considered non-bearing. For the relative proportion of development of panicles, the number of filled and empty grains was determined from each hill. A panicle was considered empty when all the grains were empty; it was considered partly filled when about one-half of the grains were partly filled. After this record of the culms was made, the panicles were threshed and the filled grains were separated from the empty ones. A representative sample from one group was taken and the grains counted. The number of grains was multiplied by the number of samples contained in the whole. The color of the cuticle was determined by actually opening about twenty grains from each plant and noting the color of each.

During the time from flowering to maturity of the third planting, homozygous strains were selected with respect to the distinctly important characters; uniform height of the plants, heavy bearing, exceptionally large or small sized grains and uniform maturity. In performing this selection, the whole field was gone over and each strain was compared with the parent plants. Repeated examinations were made during the maturing period of the plants. Final selection was made before harvesting.

The selected seeds were harvested, the strains being kept separate. They were taken to the laboratory. No study of these strains was made in the laboratory, but their seeds were cleaned, properly stored and then planted the next season. The strains were transplanted as described under heading, "Different plantings made."

At maturity, the different strains were harvested separately. Each stool was pulled up and all stools belonging to the same strain were put in one pile. The different groups of control plants were also harvested separately. In the field, the number of living stools was counted and the total number of bearing culms was recorded. All the panicles of the bearing culms from each strain were placed in cloth bags and taken to the laboratory for further study. Two labels were made. One was placed inside the bag and the other was tied outside.

In the laboratory when the seeds were thoroughly dried the actual weights were taken before and after threshing. The percentage in weight of clean palay [3] was determined by dividing the actual weight of the clean palay by the weight of the uncleaned and multiplying the quotient by 100 per cent.

How the corrected yield per plant was found

The corrected yield per plant was computed according to the method described by Mendiola (1926). This method is: The theoretical check yields of non-check rows, that is, the possible yield of the parent variety had it been planted in the rows occupied by the strains being tested is found by subtracting the actual yields of two check yields and then dividing the difference by five or six since the check or parent variety was planted after every fourth or fifth strain. The quotient is either added to or subtracted from the first check yield. If the first check yield is greater than the second, the quotient

[3] "Palay" means matured rice grains after threshing. Clean palay refers to rough rice free from empty or unfertilized grains.

is subtracted from the first check yield. The difference gives the theoretical check yield of non-check rows in place of the first strains actually planted there. The same quotient is subtracted from the first theoretical check yield of non-check rows to get the second, and so on. But if the first actual check yield is less than the second, the quotient is added to the actual first check yield to find the first theoretical check yield of non-check rows. For illustration, the yields of lots planted to check 1 and check 2 may be cited. Since the actual yield per plant of check 1 was 28.2 grams and only 22.7 grams for check 2, it may be assumed that there was a decrease in soil fertility from row check 1 to row check 2. The second check rows being planted in the sixth plot the difference in soil fertility as expressed in yield, which was 5.5 grams per hill, was divided by six. So the resulting quotient in this case, 0.92, should be subtracted from 28.20 or 27.28 which now represents the first theoretical check yield if check rows were grown in place of strain No. 469-25-4. To get the second theoretical check yield, 26.366 grams, 0.92 is subtracted from the first theoretical check yield. For the third, fourth, and fifth strains the theoretical check yields were 25.449, 24.53, and 23.665 grams, respectively.

The difference between the actual yield of a non-check row and the theoretical yield was then found and designated as minus or plus: by minus if the theoretical yield of the non-check row was greater than the actual yield and by plus, if less.

The average theoretical yield of the check row was determined by adding the check yields both actual and theoretical, and dividing the sum by the number of yields added. The corrected non-check yield per hill of each non-check row was then found by adding or subtracting the difference between the actual and theoretical yields from the average theoretical yield. The difference was subtracted if it was minus and added if it was plus. The average theoretical and corrected yields were then used as bases of selection. That is, strains the corrected yields of which were on or above their respective average theoretical yields were selected and planted the next season.

Following the method of computation described above, the theoretical or corrected yield per plant was found in the strains between two check yields.

In the 1931-1932 season, a comparative test of the promising strains and the parent variety was made. Their respective yields were measured and corrected yields were computed.

RESULTS

The results of this experiment are found in tables 1, 2, 3, 4, 5, 6, and 7.

Table 1 shows the production of bearing and non-bearing culms, empty and filled panicles per hill of selfed and non-treated plants.

Table 2 shows the production by selfing of grains with red cuticle and with white cuticle.

Table 3 gives the number of red and white cuticled grains among mass and selected seeds.

Table 4 shows the percentage of empty and filled grains of the selected grains and of the mother variety.

Table 5 presents the actual and corrected yields per hill of the selected strains compared with the check rows.

Table 6 gives the actual and corrected yields per hectare of four selected strains compared with their parents.

Table 7 shows the relative sizes of grains of two inbred strains compared with their parents.

DISCUSSION OF RESULTS

Maturity of the plants. Of all the characters observed, maturity and height of the inbred plants showed noticeable variations at the F_1 and F_2 generations, but not so pronounced at the F_3. During the initial planting the individual plants exhibited irregularity in height and in time of maturity. The inbred plants at the third generation planting matured at the same time but the control plants did not.

Bearing and non-bearing culms observed in the inbred rice plants. In the first planting (see table 1) there was obtained per plant an average of 43 bearing and 10 non-bearing culms and 1,178 filled grains and 5,039 empty. The plants produced in the open in F_1 produced an average per plant of 38 bearing with 8 non-bearing culms and 1,537 filled grains and 2,622 empty. Of the 50 plants which were selfed to produce F_2 there were observed an average of 40 bearing with 11 non-bearing culms and 1,438 filled with 4,001 empty grains per plant. Of the 1,174 seedlings planted in the open which produced F_2, there was an average of 29 bearing and 10 non-bearing culms and 2,706 filled and 1,206 empty grains. The check rows of F_2 which consisted of 184 plants had an average of 25 bearing and 8 non-bearing culms to a hill and 2,333 filled and only 896 empty grains.

These data show that by inbreeding and then allowing the grains to mature in the bagging cage, fewer filled grains were produced than empty ones. The majority of the inbred grains were empty. By

comparing F_1 inbred seeds grown in the open with those of F_2 under the same conditions, the smaller number of bearing culms was accompanied by a higher number of filled grains. These figures show that improvement by inbreeding is possible.

A high degree of variation was shown in F_1 and F_2. The smaller number of bearing culms in F_2 was accompanied by a greater production of filled grains. These results in the F_2 seem to indicate the possibility of improving and purifying the variety.

Production by selfing of grains with cuticle of different colors. As shown in table 2 there were found two distinct types, the red cuticled and the white cuticled in the Hambas variety of rice. (See fig. 2.) This variety was claimed to have been mechanically mixed with

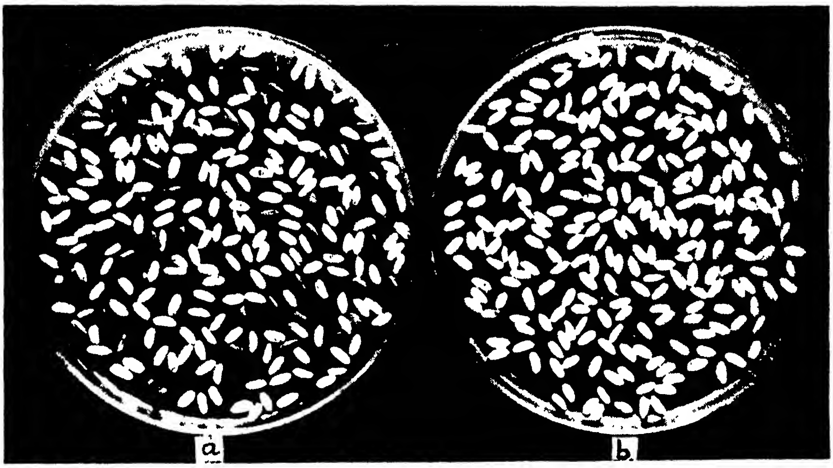

Fig. 2.—(*a*) A mixture of white and red cuticled grains of Hambas variety of rice. (*b*) White cuticled grains of strain No. 908-16-30 after inbreeding followed by selection.

red and white strains a long time ago. Of 402 plants from 18 red cuticled strains, 11 plants had white cuticled grains and 391 had red cuticled grains. Out of 847 plants from 32 white cuticled strains only 5 plants had red cuticled grains and 842 had white cuticled ones.

These data show that upon selfing the red or white cuticled strains of the Hambas variety, plants with white or red cuticled grains may be produced to a certain degree. This segregation or throwing off of red and white biotypes from apparently distinct red and white strains supports the assumption that both the red and white types of Hambas are hybrid in nature and, therefore, of heterogenous genotype. This points out that the occurrence of red and white types had probably resulted from natural crossing of varieties that were

originally pure white or pure red. In all cases although different strains produced grains of two colors the original color prevailed. There were white strains originally which produced red after inbreeding. These white strains, however, produced few red cuticled grains. Examples are strains 34, 45 and 174. Strain No. 174 had the greatest number of individuals producing a color different from the parents. In strain 143 of which only one plant was saved from destruction in the field, F_1 seeds with red cuticle produced seeds with white cuticle in F_2. Even in this plant it was evident that it produced both the red and white cuticle, but the white cuticle grain happened to be the only one saved. The genetics of red and white cuticled grains isolated through inbreeding is reserved for further studies.

From data in table 3 it is evident that of the 310 mass selected plants 77.42 per cent had white cuticled grains and 22.58 per cent had red cuticled ones. In the line selected strains with white cuticle, only 0.60 per cent of 833 plants had red cuticle and 99.40 per cent had white cuticle. Of the line selected strains out of 402 plants with red cuticle only 2.74 per cent had white cuticle and 97.26 per cent had red cuticle. The relatively low percentage of red and white cuticled segregates, which resulted from inbreeding of the red or white strains suggests at once the effectiveness of line or pedigree selection in purifying the variety. In the case of mass selected plants, it is indicated that in the future the chances of mixing the red and white strains would be greater, if selection were not practiced.

Percentage of empty and of filled grains of the selected inbred strains and of their mother variety. It may be seen in table 4 that of the 54 strains tested more than two-thirds had a higher percentage of clean palay than the mother plant. Only 16 strains had a lower percentage of clean palay than their parent variety. The parent plants had 85.08 per cent of clean palay and only 14.92 per cent of empty grains. Plants having a higher percentage of clean palay than their parent variety had a range of from 85.83 to 96.89 per cent. Of these, the strains bearing pedigree numbers 546-24-35 had 96.89 per cent of clean palay; 783-4-7 had 93.75 per cent; 783-4-14 had 93.25 per cent; 546-24-28 had 92.68 per cent; 783-4-13 had 92.47 per cent; 546-24-38 had 91.57 per cent; 783-4-1 had 91.30 per cent; and 783-4-22 had 91.00 per cent. The rest had lower than 91 per cent, but higher than that of their parent variety.

These figures indicate that with respect to high percentage of filled grains, better strains than their parent variety may be isolated by inbreeding followed by selection.

Actual and corrected yields per plant of the selected strains compared with the check rows. It may be seen in table 5 that the actual check yield ranged from 28.20 to 17.90 grams of clean palay per stool, showing that the fertility of the soil and other factors affecting the yield varied considerably. Hence, comparing only the actual yields of the check rows and the selected strains it is impossible to tell which of them were better than the control without finding first the average theoretical yield and then the corrected yield per hill of the selected strains.

The data in fifth column of the same table show that the average theoretical yield per plant between two checks was lower than the actual check yield and ranged from 17-95 to only 25.46 per cent. Comparing the corrected yields of the selected strains planted between the two checks with the average theoretical yield, it is evident that some strains had lower yields per plant, while others yielded higher. Hence, those strains the corrected yields of which were better than the theoretical were considered promising. Of these strains under study, 24 were selected. These were 469-25-7, 518-8-36, 546-24-6, 546-24-13, 546-24-15, 546-24-16, 546-24-20, 546-24-21, 546-24-23, 546-24-25, 546-24-28, 546-24-38, 783-4-10, 783-4-13, 783-4-14, 908-16-20, 908-16-29, 908-16-30, 908-16-32, 908-16-36, 908-16-37, 908-16-38, 908-16-39 and 908-16-41 gave better yields per plant than their respective control yields. Strain Nos. 908-16-29 and 546-24-28 gave exceptionally high yields. Strain No. 546-24-28 gave 30.53 grams of clean palay per hill, while strain No. 908-16-29 yielded 45.168 grams which is more than two times that of the theoretical check yield which was 20.97 grams. The average theoretical check yield had only 18.167 grams.

Yields per hectare of the selected inbred strains compared with that of their parents. The 1931-1932 test of four of the promising inbred strains and their parent variety was planted rather late in the season and consequently the plants suffered from the early drought that prevailed during that season. Three of the inbred strains, however, gave higher yield than the mother variety. As shown in table 6, strain Nos. 518-8-36, 908-16-29 and 908-16-30 gave a greater yield per hectare than the parent variety, while strain No. 546-24-28 gave a lower yield. Strain No. 518-8-36 gave a yield per hectare 19.679 per cent higher than that of its parent; strain No. 908-16-29, 17.288 per cent; and strain No. 908-16-30, 15.766 per cent. Strain No. 546-24-28 gave a yield 27.492 per cent less than that of the parent variety.

During the 1932-1933 season test only two strains proved superior in yield to the parent variety. Strain No. 908-16-29 gave a yield nearly two and one-half cavans per hectare greater than the parent and strain No. 518-8-36 nearly two cavans greater.

Size of grains of inbred strains compared with that of their parent. Relative size of grains of the different inbred strains was one of the characters used as a basis in preliminary selection. It was observed that the different inbred strains varied as to size and shape of grains. Some of the strains had larger grains than those of the parent plants while others had smaller. For example, strain No. 783-4-13 had larger grains and strain No. 813 had smaller than those of their parents. (See table 7.) Strain No. 783-4-13 had grains averaging 9.459 ± 0.0188 cm. in length, 3.232 ± 0.0067 cm. in greatest diameter; and 2.150 ± 0.0073 cm. in thickness. The parent variety had grains averaging only 8.30 ± 0.0130 cm. in length, 2.70 ± 0.0388 cm. in width, and 1.88 ± 0.0102 cm. in thickness. Strain No. 813 had grains averaging 7.450 ± 0.0001 cm. in length, 2.646 ± 0.00001 cm. in width, and 1.995 ± 0.00001 cm. in thickness. Comparing the grains of strain No. 783-4-13 with those of the parent plants, it was found that the difference was in favor of the strain and by computation the difference was found to be significant. The difference of their means was 1.1590 ± 0.0445 grams.

These figures show that by inbreeding it is possible to improve the size and shape of the grains.

SUMMARY OF CONCLUSIONS

The results obtained by inbreeding Hambas variety of rice may be summarized as follows:

1. Hambas, an old variety of rice grown for the market in Los Baños and other regions in the Philippines consists of two distinct types; the red type with red cuticled grains and the white type with white cuticled grains. This variety is supposedly a natural hybrid between varieties, one of which had a red cuticle and the other a white cuticle. This supposition is supported by the production of white cuticled grains by selfing the red cuticled strains. Red cuticled grains were also obtained by inbreeding some of the white cuticled strains.

2. Some selected strains were found to have a longer period of maturity than the parent variety, others a shorter one.

3. By selfing, the production of filled grains was reduced, but through continuous planting of the inbred strains in the open the production of filled grains was increased.

4. By selfing it was possible to isolate strains with larger or smaller grains than the original variety.

5. The percentage of filled and of empty grains in a panicle was increased by selfing.

6. Inbreeding affected the yield of the 24 strains; of these, the yields were found to be higher than their average theoretical check yields. Strains Nos. 908-16-29 and 546-24-28 had exceptionally high percentages of clean palay per hill. The other selected strains were Nos. 469-25-7, 518-8-36, 546-24-6, 546-24-13, 546-24-15, 546-24-16, 546-24-20, 546-24-21, 546-24-23, 546-24-25, 546-24-38, 783-4-10, 783-4-13, 783-4-14, 908-16-20, 908-16-30, 908-16-32, 908-16-36, 908-16-37, 908-16-38, 908-16-39 and 908-16-41. (See fig. 3.)

7. In subsequent comparative tests the undesirable strains were gradually eliminated. At the sixth generation only two strains were

Fig. 3.—Showing actual yields per plot of five of the selected inbred strains of Hambas variety (*a*, *b*, *d*, *e*, and *f*) and their parent plants (*c*). Note their respective yields per hill in the bottles.

selected. These two selected strains of promising importance were Nos. 908-16-29 and 518-8-36.

8. The inbred plants yielded fewer field grains than the check, although the check had fewer bearing culms. This difference shows that the treatment had some effect on the production of bearing culms.

RECOMMENDATIONS

1. As the Hambas variety is not pure with respect to grain color of cuticle, it is recommended that necessary steps be taken to lessen or stop altogether further propagation of the mixed strains for planting. A uniform color of the grain increases the commercial value of rice.

2. In handling the inbreeding work in a rice variety the more individuals planted the greater the chances of isolating the desired strains.

3. While the plants are being studied in the laboratory, a room for storage should be provided. If the rice heads are piled as is the practice in handling many grains are shaken out and lost.

4. The selected strains should be handled so as to prevent any mechanical mixing of the grains. Close personal supervision is very essential.

5. In selecting the promising strains it is advisable to inspect the plants frequently from transplanting to maturity.

6. The plants to be selfed should be bagged at proper time of blooming.

7. While the breeder may plan to observe definite characters, other characters which may spontaneously arise during the progress of the work should be considered also. The final expression of the results of the work counts more than the theoretical observations.

8. The selected strains 908-16-29 and 518-8-36 obtained should, with the coöperation of the rice growers, be propagated and tried with great care under various conditions.

9. Undoubtedly, other commercial rice varieties in the Philippines have some varying degrees of mixtures either mechanical or genetic. Inbreeding should be practiced with each variety of rice with a view of purifying and isolating better strains which are essential to early production of desirable rice hybrids.

NOTE

After this paper was in press, the writers' attention was called to the report of Dr. L. Koch on "Past, present and future in the obtaining and spreading of superior rice varieties in the Dutch East Indies" published, 1930, in the *Reports of Fourth Pacific Science Congress*, Java, 1929, Vol. IV, P. 9-14. The paper includes a summary of rice inbreeding work in Java which is here quoted:

> Already during the first few years rice had been selected by the pure line method, but without strict inbreeding. The bagging of flowering ears proved later to be necessary as the air of Buitenzorg makes the chance of natural crossing far from negligible.
>
> Comparative trials between populations and lines (the latter inadequately inbred) made it clear, that the method of selection followed up till 1915 was useless.
>
> A thorough investigation of this subject followed which lasted for three years. It proved clearly, that the so called lines were not better than the unselected varieties, most probably on account of:
>
> a) the insufficient homozygosity and superiority of the lines.
>
> b) the fact, that a mixture of lines and hybrids, such as found in the population, had the advantage of being more pliable and therefore more suited to varying conditions met with in general cultivation.

Inbreeding, by bagging and in some instances by planting wide apart, has been in use during the seasons following 1922, generally with success.

The conditions for successful work had been much improved compared with those of 15 years earlier.

Not only had a thorough knowledge of the cultivation of the rice plant been gathered, but much more was known about the peculiarities of several varieties, of the methods of breeding, the planning of variety trials etc. So, though real successes were few, a great amount of valuable information was compiled, without which breeding could not have proceeded.

After inbreeding and selecting some 13 standard varieties for several generations, the selected strains were compared during the rainy season of 1927-1928 with the unselected varieties. The results are in some degree remarkable.

In several instances strains were procured, that outyielded the unselected varieties up to 25%. Some other strains however gave less than the population.

TABLE 1

Production of bearing and non-bearing culms, empty and filled grains per hill of selfed and non-treated plants

TREATMENT	PLANTS STUDIED	BEARING CULMS PER HILL	NON-BEARING CULMS PER HILL	FILLED GRAINS PER HILL	EMPTY GRAINS PER HILL
	number	*number*	*number*	*number*	*number*
Selfed plants to produce F_1	50	43	10	1178	5,039
Untreated plants to obtain F_1 ..	250	38	8	1537	2,622
Selfed F_1 plants to produce F_2 .	50	40	11	1438	4,001
Untreated plants to obtain F_2 .	1,174	29	10	2706	1,206
Check rows of F_2	184	25	8	2333	896

TABLE 2

Production, by selfing, of grains with red cuticle and with white cuticle

Original plant numbers with red cuticle

NO.	ORIGINAL PEDIGREE NO.	HILLS STUDIED	HILLS WITH WHITE CUTICLED GRAINS	HILLS WITH RED CUTICLED GRAINS
		number	*number*	*number*
1	43	35	0	35
2	47	8	0	8
3	78	31	0	31
4	83	7	0	7
5	91	18	0	18
6	100	33	1	32
7	104	6	0	6
8	137	22	0	22
9	143	1	1	0
10	174	37	5	32
11	188	39	0	39
12	256	17	0	17
13	261	31	1	30
14	285	17	0	17
15	586	13	1	12
16	641	27	0	27
17	709	23	2	21
18	855	37	0	37
	Total	402	11	391

Original plant numbers with white cuticle

NO.	ORIGINAL PEDIGREE NO.	HILLS STUDIED	HILLS WITH WHITE CUTICLED GRAINS	HILLS WITH RED CUTICLED GRAINS
1	16	33	33	0
2	19	20	20	0
3	34	25	24	1
4	44	14	14	0
5	45	39	38	1
6	59	20	20	0
7	80	34	34	0
8	113	18	18	0
9	168	34	34	0
10	199	8	8	0
11	272	19	19	0
12	287	34	34	0
13	302	31	29	2
14	340	24	24	0
15	400	26	26	0
16	469	18	18	0
17	475	23	23	0
18	507	39	39	0
19	518	36	36	0
20	522	34	33	1
21	524	18	18	0
22	546	36	36	0
23	668	23	23	0
24	692	26	26	0
25	745	26	26	0
26	774	23	23	0
27	783	31	31	0
28	797	24	24	0
29	816	24	24	0
30	843	32	32	0
31	892	33	33	0
32	908	22	22	0
	Total	847	842	5

TABLE 8

Presence of red and white cuticled grains among mass and selected seeds

TREATMENT	HILLS STUDIED	HILLS WITH WHITE CUTICLED GRAINS		HILLS WITH RED CUTICLED GRAINS	
	number	*number*	*per cent*	*number*	*per cent*
Mass selected grains	310	240	77.42	70	22.58
Line selected hills with white cuticled grains ..	833	828	99.40	5	0.60
Line selected hills with red cuticled grains	402	11	2.74	39	97.26

TABLE 4

Showing data on yield of the selected strains and their mother variety

PEDIGREE NO.	WEIGHT OF THRESHED PALAY	WEIGHT OF CLEAN PALAY	WEIGHT OF EMPTY GRAINS	CLEAN PALAY	EMPTY GRAINS
	grams	*grams*	*grams*	*per cent*	*per cent*
469-25- 4	1540	1370	170	88.96	11.04
469-25- 7	2770	2380	390	85.92	14.08
518- 8-32	2600	2270	330	87.31	12.69
546-24- 1	1270	1140	130	89.76	10.24
546-24- 6	2270	1960	310	86.34	13.65
546-24-13	1990	1770	220	88.94	11.05
546-24-16	1460	1290	170	88.35	11.65
546-24-20	1280	1110	170	86.72	13.28
546-24-21	1610	1390	220	86.33	13.67
546-24-23	1200	1030	170	85.83	14.17
546-24-28	2310	2140	170	92.68	7.32
546-24-35	1930	1870	60	96.89	3.11
546-24-36	1490	1309	181	87.85	12.15
546-24-38	1660	1520	140	91.57	8.43
546-24-41	1750	1540	210	88.00	12.00
546-24-42	1800	1600	200	88.89	11.11
546-24-43	1280	1110	170	86.72	13.28
546-24-44	1825	1660	165	90.90	9.04
783- 4- 1	1150	1050	100	91.30	8.70
783- 4- 7	1440	1350	90	93.75	6.25
783- 4-10	2540	2230	310	87.32	12.68
783- 4-13	1990	1840	150	92.47	7.53
783- 4-20	2320	2060	260	88.79	11.21
783- 4-14	2520	2350	170	93.25	6.75
783- 4-22	3000	2730	270	91.00	9.00
908-16- 4	2800	2480	320	89.28	10.72
908-16-11	3500	3130	370	89.43	10.57
908-16-20	3100	2810	290	90.64	9.36
908-16-29	5110	4620	490	90.41	9.59
908-16-30	3700	3330	370	90.00	10.00
908-16-32	3480	3090	390	89.37	10.63
908-16-36	2780	2480	300	89.21	10.79
908-16-37	2900	2530	370	87.24	12.76
908-16-38	3260	2920	340	89.57	10.43
908-16-39	3250	2840	410	87.38	12.62
908-16-41	3300	2840	460	86.06	13.94
91-17- 3	3930	3560	370	90.58	9.42
Control [a]	2565	2179	395	85.08	14.92
469-25-17	3370	2800	570	83.09	16.91
518- 4- 4	3000	1360	1640	45.33	54.62
518- 8-36	3470	2890	580	83.28	16.72
518- 8-38	2250	970	1280	43.11	56.89
546-24- 2	1450	1180	270	81.40	18.62
546-24- 4	2080	1570	410	80.29	19.71
546-24- 5	1960	1650	310	84.18	15.82
546-24- 9	1410	1190	220	84.00	15.60
546-24-15	2000	1690	310	84.50	15.50
546-24-22	930	790	140	84.95	15.05
546-24-24	3238	1040	2198	32.12	67.88
546-24-25	2360	1920	440	81.35	18.65
783- 4- 9	2190	1740	450	79.45	20.55
783- 4-11	1770	1350	420	76.27	23.73
908-16-17	4670	2450	2220	52.46	47.54
908-16-15	3110	1500	1610	46.30	53.70

[a] Average of all control rows.

TABLE 5

Actual and corrected yields per hill of the selected strains compared with the check rows

STRAIN NO.	AV. WT. OF CLEAN PALAY PER HILL	THEORETICAL CHECK YIELD OF NON-CHECK ROWS PER HILL	DIFFERENCE BETWEEN ACTUAL AND THEORETICAL YIELD PER STOOL	AV. THEORETICAL YIELD PER HILL	CORRECTED YIELD PER HILL
	grams	*grams*	*grams*	*grams*	*grams*
Check 1	28.200				
469-25- 4	13.564	27.283	—13.719		11.737
469-25- 7	27.674	26.366	+ 1.314		26.770
469-25-17	24.778	25.449	— 0.662	25.456	24.794
518- 8- 4	11.525	24.532	—12.995		12.461
518- 8-32	23.402	23.665	— 0.198		25.258
Check 2	22.700				
518- 8-36	27.788	22.430	+ 5.358		27.247
518- 8-38	9.797	22.160	—12.363		9.526
546-24- 1	15.200	21.890	— 6.690		15.199
546-24- 2	14.935	21.620	— 6.685	21.889	15.204
546-24- 4	21.139	21.350	— 0.211		21.678
Check 3	21.075				
546-24- 5	17.934	20.546	— 2.612		16.875
546-24- 6	20.851	20.017	+ 0.834		20.321
546-24- 9	14.337	19.488	— 5.151	19.487	14.336
546-24-13	21.324	18.959	+ 2.365		21.852
546-24-15	20.119	18.430	+ 1.689		21.176
Check 4	17.900				
546-24-16	23.035	17.917	+ 5.118		23.068
546-24-20	20.943	17.934	+ 3.009		20.959
546-24-21	18.533	17.951	+ 0.582	17.950	18.532
546-24-22	17.954	17.968	— 0.014		17.936
546-24-23	21.458	17.985	+ 3.473		21.423
Check 5	18.000				
546-24-24	11.818	18.067	— 6.249		11.918
546-24-25	20.000	18.134	+ 1.866	18.167	20.033
546-24-28	30.571	18.201	+12.370		30.537
546-24-35	16.260	18.268	— 2.008		16.159
Check 6	18.333				
546-24-38'	18.534	18.480	+ 0.054		18.827
546-24-41	18.554	18.627	— 0.073		18.700
546-24-42	16.666	18.774	— 2.108	18.773	16.665
546-24-43	17.343	18.921	— 1.578		17.195
546-24-44	17.113	19.068	— 1.955		16.818
Check 7	19.213				
783- 4- 1	15.909	19.343	— 3.434		16.168
783- 4- 7	16.071	19.473	— 3.402		16.200
783- 4- 9	15.963	19.603	— 3.640	19.602	15.962
783- 4-10	21.238	19.733	+ 1.505		21.107
783- 4-11	17.763	19.863	— 2.100		17.502
Check 8	19.990				
783- 4-13	22.168	21.204	+ 0.961		24.595
783- 4-20	21.237	22.418	— 1.181		22.450
783- 4-14	24.478	23.632	+ 0.846	23.631	24.477
783- 4-22	23.135	24.846	— 1.711		21.920
908-16- 4	21.946	26.060	— 4.114		19.517
Check 9	27.272				
908-16-11	25.447	26.128	— 0.681		24.302
908-16-17	21.120	24.984	— 3.864	24.983	21.119
908-16-15	15.463	23.840	— 8.377		16.606
Check 10	22.695				
908-16-20	27.018	22.121	+ 4.897		25.870
908-16-29	45.742	21.547	+24.195		45.168
908-16-30	31.121	20.973	+10.148	20.973	31.121
908-16 32	24.919	20.399	+ 4.520		25.498
908-16-36	22.545	19.825	+ 2.720		23.693
Check 11	19.252				
908-16-37	22.792	19.699	+ 3.093		23.462
908-16-38	24.132	20.146	+ 3.986		24.855
908-16-39	22.015	20.593	+ 1.422	20.369	21.791
908-16-41	23.278	21.040	+ 2.238		22.607
Check 12	21.487				

TABLE 6

Actual and corrected yields per hectare of four promising inbred strains compared with their parent variety

STRAIN NO.	ACTUAL YIELD PER HECTARE [a]	THEORETICAL YIELD OF NON-CHECK STRAINS	DIFFERENCE BETWEEN ACTUAL AND THEORETICAL YIELDS	AV. THEORETICAL YIELD PER HA.	CORRECTED YIELD PER HA.	INCREASE	DECREASE
	cavans	*cavans*	*cavans*	*cavans*	*cavans*	*per cent*	*per cent*
Control 1 ..	30.39	—	—	—	—	—	—
518- 8-36 ..	35.92	30.042	+5.789	—	35.747	19.679	—
908-16-29 ..	34.86	29.696	+5.164	29.869	35.033	17.288	—
Control 2 ..	29.35	—	—	—	—	—	—
546-24-28 ..	22.48	31.390	−8.91	—	23.50	—	27.492
908-16-30 ..	38.54	33.430	+5.11	32.41	37.52	15.766	—
Control 3 ..	35.47	—	—	—	—	—	—

[a] The low yield of the parent (Hambas) variety and the promising selected strains was due to effects of drought in early part of 1931-32 season.

TABLE 7

Size of grains of inbred strains compared with their parent variety

STRAIN NO.	AVERAGE LENGTH	AVERAGE GREATEST WIDTH	AVERAGE THICKNESS
	mm.	*mm.*	*mm.*
783-4-13	9.459 ± 0.0188	3.232 ± 0.0067	2.150 ± 0.0073
Parent variety	8.3 ± 0.0130	2.7 ± 0.0388	1.88 ± 0.0102
813 [a]	7.450 ± 0.0001	2.646 ± 0.00001	1.995 ± 0.00001

[a] This number was eliminated because of poor yield and small sized grains.

ADDITIONAL CYANOPHORIC PLANTS OF THE MAQUILING REGION: IV[1]

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Herbert (1922), Juliano (1923) and Peralta (1928) published lists of cyanophoric plants found in the Maquiling region; the list herein given is an addenda to these three lists. Numerous species were tested and those found to contain prussic or hydrocyanic acid and not given in any of the three previous reports are included in this list. The simple modified Guignard test given by Herbert (1922) was employed in this study, and the procedure followed was that described by Peralta (1928). Some of the tests were carried by College of Veterinary Science students working under the supervision of the writer in a course in Veterinary Botany at the College of Agriculture during December, 1932, and January, 1933. The scientific and vernacular names of the plants herein included were checked with Merrill's (1923-1926) *An Enumeration of Philippine Flowering Plants.*

ACANTHACEAE

Blechum brownei (dayang, sapin-sápin): Negative in stems; trace in roots and leaves.

Hemigraphis strigosa: Trace in roots and stems.

Pseuderanthemum sp.: Trace in stems and leaves.

AMARANTHACEAE

Alternanthera sessilis (boñga-boñga): Trace in roots and leaves.

ANONACEAE

Anaxagorea luzonensis (dalairo, káhoi-dalaga, kolestaláno, sagáak, taláylo): Positive in leaves.

Artabotrys suaveolens (súsong-damulag): Trace in stems; positive in leaves.

APOCYNACEAE

Alstonia scholaris (ditá, ditáa): Slightly positive in stems and leaves.

Voacanga globosa (bayag-kambing, bayag-usá, pandacaking-kalabáu): Positive in leaves.

ARACEAE

Pothoidium lobbianum (barálta, vara alta): Slightly positive in stems; positive in leaves.

Scindapsus aureus (lukmói): Trace in stems and leaves.

[1] Experiment Station contribution No. 899. Received for publication, June 13, 1933.

ARALIACEAE

Nothopanax fruticosum (papua): Trace in stems and leaves.

Schefflera odorata (galámai-amo, lima-lima): Trace in leaves; positive in stems.

BIGNONIACEAE

Parmentiera cereifera (candle tree): Trace in roots and leaves; slightly positive in fruits.

BURSERACEAE

Canarium villosum (anunggi, pagsaingin): Positive in roots and stems.

COMPOSITAE

Ageratum conyzoides (damong-pallas, kolokong-kabáyo): Trace in roots and stems; positive in leaves.

Cosmos sulphureus (amarillo): Trace in roots and stems; positive in leaves.

Elephantopus spicatus (dila-dila, sigang-dágat): Trace in roots; slightly positive in stems; positive in leaves.

Emilia sonchifolia (marsilanana, tagulinau, tagulinas): Trace in roots, stems, and leaves.

CONVOLVULACEAE

Hewittia sublobata: Trace in roots.

Ipomoea cairica (aurora): Trace in roots and leaves.

CUCURBITACEAE

Bryonopsis laciniosa (melong-uák): Negative in roots and stems; trace in leaves.

CYPERACEAE

Kyllinga monocephala (anuang, botoncillio, muthá, mustra): Trace in the nutlets, roots and stems.

DILLENIACEAE

Tetracera scandens (malakatmon, malbas-tig-bálang): Trace in stems and leaves.

DIOSCOREACEAE

Dioscorea hispida (kalut, káyos, nami): Positive in storage roots, stems, and leaves.

ERYTHROXYLACEAE

Erythroxylon coca (cocaine plant): Positive in leaves.

EUPHORBIACEAE

Acalypha wilkesiana: Positive in leaves; trace in stems.

Biophytum sensitivum (damong-bingkálat, makahiang-lalaki, makahia): Trace in stems and leaves.

Claoxylon elongatum: Slightly positive in stems; positive in leaves and roots.

Homalanthus populneus (baiánti, botabóta, búta, maladúron): Trace in bark of stems; positive in leaves.

Hura crepitans: Positive in bark; trace in leaves.

Macaranga grandifolia (binúang, bingábing, biláun): Positive in roots.

Macaranga tanarius (binúnga): Positive in stems; trace in leaves and roots.

Melanolepis multiglandulosa (alim): Positive in leaves; trace in stems.

GRAMINEAE

Eleusine indica (parag-is): Trace in flowers.

Rottboellia exaltata (agiñgai): Trace in roots.

Setaria palmifolia: Trace in roots.

LABIATAE

Hyptis suaveolens (suag-kabayo): Trace in roots and stems; slightly positive in leaves.

LEGUMINOSAE

Bauhinia tomentosa: Positive in fruits and more so in the leaves; trace in stems.

Cassia bacillaris: Trace in stems and leaves; positive in roots.

Cassia tora (katandá): Positive in leaves and roots; trace in bark and fruits.

Crotalaria juncea: Positive in stems.

Dalbergia ferruginea (kulik-manók): Positive in leaves and roots.

Derris elliptica (tublí): Trace in roots.

Desmodium gangeticum (dikit-dikit, paiang-paiang): Trace in leaves, stems, and roots.

Desmodium laxiflorum (mangkít): Slightly positive in leaves; trace in stems and roots.

Desmodium triflorum (pakpák-láñgan): Trace in leaves.

Mucuna pruriens (lípai, nípai): Trace in fruits.

Teramnus labialis (mani-manían): Trace in roots; positive in leaves.

LECYTHIDACEAE

Barringtonia racemosa (pótat, pútat): Trace in stems.

LILLACEAE

Allium cepa (sibuyas): Trace in leaves.

Állium sativum (báuang): Trace in leaves.

MALVACEAE

Sida javensis (hapúnang-niknik): Positive in roots; trace in leaves and stems.

Urena lobata (kulútan): Positive in roots, bark, leaves and fruits.

MELIACEAE

Dysoxylum decandrum (igui, tadiang-kalabáu): Trace in leaves and stems.

Melia azedarach (paraiso): Positive in leaves.

MENISPERMACEAE

Anamirta cocculus (ligtang); Very positive in roots; slightly positive in leaves; Kalaw and Sacay (1925) found the acid only in the bark.

Pycnarrhena manillensis (ambal, mamañgal): Positive in roots; trace in leaves.

MORACEAE

Ficus minahassae (ayúmit, hagímit): Positive in leaves; slightly positive in stems.

Streblus asper (kalios): Positive in leaves; trace in stems.

MORINGACEAE

Moringa oleifera (malúngai): Trace in stems.

MUSACEAE

Heliconia bihai: Trace in roots and leaves.

MYRTACEAE

Memecylon floribundum: Trace in stems, leaves and fruits.

OPHIOGLOSSACEAE

Helminthostachys zeylanica (tungkod-lañgit): Trace in roots.

OXALIDACEAE

Oxalis repens (taiñgang-dagá): Trace in stems; positive in fruits.

PIPERACEAE

Piper umbellatum (kubámba): Positive in leaves; trace in stems.

RUBIACEAE

Ophiorrhiza mungos (payang-payang-gúbat): Trace in leaves and stems.

SAPINDACEAE

Allophyllus dimorphus (laret, malalagúndi): Positive in roots and leaves; trace in stems.

Harpullia arborea (puás): Positive in leaves; Kalaw and Sacay (1925) did not find any trace of the acid in leaves, bark, and roots of plants growing in Batangas and Bulacan.

STERCULIACEAE

Pterospermum obliquum (bayóg): Trace in stems and leaves.

TILIACEAE

Corchorus acutangulus (salúlot): Trace in roots and stems.

Corchorus olitorius (pasau-na-habá): Trace in stems and leaves; positive in roots.

ULMACEAE

Celtis luzonica (seedling) (malaikmo): Trace in roots.

UMBELLIFERAE

Centella asiatica (takip-kohól, takip-susó, tapiñgan-dagá): Trace in roots and leaves; Kalaw and Sacay (1925) found none of the acid in plants collected from Batangas and Bulacan.

URTICACEAE

Pipturus arborescens (dalúnot): Trace in leaves.

VERBENACEAE

Duranta repens: Positive in leaves and fruits.

VITACEAE

Columella geniculata (sampang): Trace in roots and stems.

Leea manillensis (abang-ábang, kulatai): Trace in leaves.

Tetrastigma loheri (ayu): Trace in leaves and stems.

ZINGIBERACEAE

Costus speciosus: Trace in rhizomes and leaves.

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COST OF PRODUCING SUGAR CANE IN THE COLLEGE OF AGRICULTURE [1]

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Sugar cane (*Saccharum officinarum*) is one of the most important money crops in the Philippines. It is grown on both haciendas and small farms. It is important that cane growers should know what it costs them to grow sugar cane.

The objects of this study were to determine the cost of producing sugar cane and the net gain per hectare and per ton of the cane produced in the College of Agriculture.

The work was conducted from January, 1930 to February, 1933, a period of twenty-six months. The plant cane culture covered a period of fourteen months from the preparation of land to harvesting, and the ratoon culture covered a period of twelve months. The field used was located in the College Experiment Station. Some of the canes were milled in the U. P. Sugar Mill located at the College and some were sent to the Calamba Sugar Estate at Canlubang, Calamba, Laguna.

MATERIALS AND METHODS

Land

A lot, 1.54 hectare in area, in the Experiment Station field was used for this experiment. The soil is clay loam and fairly suitable for the growing of sugar cane. There was no fertilization of any kind, but the field had been planted to leguminous crops the previous year.

Variety of cane

In this study three varieties of canes were used; namely, Luzon White, Pampanga Red, and Mauritius 1900. Of these varieties, Luzon White was used in the greater quantity. The points were taken from the previous harvest of the canes grown in the College Experiment Station field.

[1] Portions of the material in this paper were in the thesis presented, 1933, by the junior author for graduation with the degree of Bachelor of Science in Agriculture, from the College of Agriculture No. 355; Experiment Station contribution No. 900.

Plows and harrows

Native plows. A general purpose native plow, such as is commonly used by the farmers in Laguna, was used in the preparation of the land and in cultivation. It has an average width of cut of about four inches (10-16 cm.) and weighs about 17.5 kilograms. It has no landing adjustment, but has the necessary depth adjustments. It cost ₱17.00, including its accessories.

Native harrow, or calmot. For harrowing, the native harrow, or *calmot* was used. It is made of bamboo stumps fastened together by long pegs. The nodes are cut off leaving about six to eight cm. which serve as teeth. The width of cut is about 1.21 meters. This harrow costs ₱5.00 and lasts three or four years.

Tractor and tractor plow

Tractor. The Standard Fordson model 1929 was used. This tractor has approximately 10 horse power at the drawbar and 20 horse power at the belt when the engine is running at the speed of 1000 revolutions per minute. For fuel, gasoline was used for starting the tractor and kerosene for field operations.

Disc plow. With the tractor a disc plow, the Oliver No. 42, was used. It has two discs 24 inches in diameter. The whole mechanism is mounted on three wheels. There are two furrow wheels and one rear wheel. The rear furrow wheel is inclined away from the land. It is heavier than the other two so that it will not be lifted out of the furrow but will hold the plow in position. In making the turn at the furrow end, the discs are lifted by means of a trip rope tied at the trip lever and connected to the driver's seat. This is operated by the driver. There are two levers for depth and level adjustments.

CULTURAL METHODS

Plant canes

Preparation of land. The first plowing was done with the disc plow hitched to the Fordson tractor. It took 12 hours to plow the whole area of 1.54 hectare. The second and third plowings were done with the native plows drawn by a bullock.

The lot was harrowed thoroughly after the third plowing. The *calmot* pulled by a bullock was passed over the plowed lot several times until the large clods were pulverized. To make it heavier and so increase its efficiency, stones were placed on the harrow.

Just before planting, the field was furrowed with the native plow. The furrows were made one meter apart and about 6 to 8 inches (15.24 to 20.32 cm.) deep.

Planting. When the points were cut, care was taken to select only good ones. The points were hauled to the creek and soaked for 48 hours. They were then hauled to the field to be planted.

In planting two men distributed the points in the furrows, dropping them at points 80 to 90 centimeters apart. These men were followed by two other men who covered the points.

Cultivation and weeding. The first work in cultivation was started a month after the canes had been planted. The soil was plowed towards the base of the plants on both sides. This process is called "hilling-up". In this operation most of the weeds were plowed under.

Three months after the first cultivation the plow was again passed along the rows near the base on each side of the plants so that the soil was thrown away from the plants. This process is called "off-barring."

A month later the final cultivation or "hilling-up" was done. Most of the weeds were killed during the three cultivations given. After the final cultivation the plants were left until they were mature and ready for harvest.

Ratoon

Cultivation. After harvesting the plant canes in February, 1932, the whole cane field was burned over. Two weeks later the plow was passed on each side of the base of the cane stubs throwing the soil away. This operation was the same as the "off-barring" in plant canes. The field was left until about the end of the month of May 1932, when the weeds began to appear. At that time the ratoons had germinated also. The second cultivation which was "hilling-up" was done. Most of the newly germinated weeds were plowed under.

About the end of June, 1932, the plants were cultivated again which was the second "off-barring" but the third cultivation. A month later the plants were "hilled-up" which was the last cultivation. There was no other cultivation before the ratoon was harvested.

HARVESTING

Topping and cutting

With bolos, topping and cutting were done at the same time but by different men. The men cutting the tops were followed by the cutters. In cutting the tops, most of the points were saved for the next planting. Before the canes were cut the base of the plants were cleared of dried leaves so that the cutting could be done very close to

the ground. The cut canes were then piled ready for hauling. Some of the canes were hauled and milled in the U. P. Sugar Mill which is about 1.2 kilometers from the cane field.

EXPERIMENT AND RESULTS

Table 1 shows the labor cost for the different farm operations for plant canes. The labor cost for plant canes per hectare was ₱154.77. In computing the cost of labor, the tractor driver was given a rate of ₱0.16 per hour, plowman, ₱0.11 per hour and animal, ₱0.11 per hour.

Table 2 shows the labor cost for the different farm operations for ratoon. The labor cost per hectare was ₱66.31.

Table 3 shows the depreciation of the different farm implements and interest on the investment. The depreciation and interest per hectare for plant cane was ₱5.94 and ₱1.94 for ratoon.

In computing the depreciation and interest on the investment in implements, the following formulas by Catambay (1931) were used:

$$\text{Depreciation per day in pesos} = \frac{cd}{ym}$$

$$\text{Interest per day in pesos} = \frac{crd}{365}$$

Where c = Cost of machinery or implement in pesos
d = Number of days used (9 hours a day)
y = Life of implements in years
m = Maximum number of days that the implement or machine is used in one year
r = rate of interest in per cent per year on money invested in the machine or implement

Table 4 shows the total supply and land cost. The supply and land cost for plant cane per hectare was ₱46.87 and ₱20.00 for ratoon. These figures include the cost of points used, cost of fuel and lubricant in plowing with the tractor and rent of the land. The land rent was based on ₱20.00 per hectare per year.

Table 5 shows the cost of the different farm operations. The costs for plant canes per hectare were; ₱34.53 for plowing, ₱3.47 for harrowing, ₱8.33 for furrowing, ₱8.88 for the preparation of cuttings, ₱8.50 for planting, ₱31.61 for cultivation, and ₱73.21 for harvesting.

For the ratoon crop the cost per hectare was ₱32.76 for cultivation and ₱35.26 for harvesting.

Table 6 shows the itemized cost of production. The total labor cost per hectare for plant cane was ₱154.77 including hauling and ₱118.49 when cost of cut canes was excluded. For ratoon it cost ₱66.31 including hauling and ₱48.45 excluding hauling.

The total depreciation and interest for plant canes was ₱5.94 including cost of hauling, and ₱3.97 excluding hauling. For ratoon it cost ₱1.94 including hauling, and ₱.97 when the cost of hauling was not included.

The total supply and land cost was ₱46.87 for plant cane and ₱20.00 for ratoon.

The total cost of production per hectare for plant cane was ₱207.58 including cost of hauling, and ₱169.33 excluding cost of hauling cut canes. For ratoon it cost ₱88.25 when the canes were hauled and ₱69.42 when the canes were just cut and piled in the field ready for hauling.

Table 7 shows the cost of production per ton of canes. It cost ₱4.57 per ton for plant canes including hauling, and ₱3.73 when just cut and piled in the field ready for hauling.

For ratoon it cost ₱4.79 per ton when hauled, and ₱3.77 when the cut canes were just piled in the field.

Table 8 shows the cost of production per hectare when the canes were delivered to Calamba Sugar Estate, at Canlubang, Calamba Laguna. It cost ₱243.37 per hectare for plant canes, and ₱99.56 for ratoon.

Table 9 shows the cost of production per ton of canes delivered to Calamba Sugar Estate. It cost ₱5.37 per ton for plant canes and ₱5.40 for ratoon.

DISCUSSION OF RESULTS

Field operations

Preparation of land. The field was plowed for the first time with a 2-24 inch disc plow drawn by a Fordson tractor. The disc partly pulverized the soil so that the field was not harrowed after this operation. The second and third plowings, were with the native plow as the soil was not so hard as when the first plowing was done. The harrowing that followed the third plowing further pulverized the soil and made the field level and ready for planting.

Furrowing. Sugar cane requires deep furrows. The native plow makes only a shallow furrow. So the plow had to be run three times before a furrow about 8 to 10 inches (20.32 to 25.40 cm.) deep was made.

Planting. It was observed that in order to obtain the necessary compactness of the soil around the planted cuttings, the planters usually stepped on the soil after covering them. About ten days after planting the young plants came up.

Cultivation. During the first cultivation of the plant canes, which was a month after planting, very few weeds were killed because few of the weed seeds had germinated. In the next cultivation, about three months later, most of the weeds were plowed under. At this time there was a rather thick growth of weeds between the rows. In the third and final cultivation fewer weeds were killed than in the second as only the survivors were left.

In the case of the ratoon, the first cultivation was about two weeks after harvesting the plant canes in February, 1932. There were practically no weeds as the field had just been burned. The next cultivation was about the end of May, 1932 when the weeds had begun to grow. About the end of June, 1932, the ratoon field was again cultivated. At this time there was a rather thick growth of weeds. The fourth and final cultivation of the ratoon was about the end of July, 1932. The growth of weeds was thinner than at the third cultivation but the height of the plants which was about one meter hindered the operation.

Harvesting and hauling. It was observed that the cleaning away of trash around the base of the canes consumed considerable time, as it was thickly covered with dried leaves. It was necessary to remove these before the canes were cut, so the whole cane could be seen, else portions of the stem would be left as stubs.

In loading the cut canes on bull carts for hauling to the mill, it was found from about fifty trials that it took one man an average of 37 minutes to load one cart. The average load of one bull cart was 507 kilograms. The unloading took one man 19 minutes. In hauling the canes, it was found that the average speed of the animals pulling a loaded cart was 1.8 kilometers per hour.

Labor requirement per hectare

Plant canes. Under column 4 in table 1, the number of hours required for the different operations is recorded. It may be observed from this table that among the field operations harvesting required the longest time. The topping required 123.3 man hours. Cutting canes required 185.0 man hours. Hauling, including loading and unloading, required 164.9 man hours and 164.9 animal hours. The total labor requirement for harvesting, including hauling, was 473.2 man hours and 164.9 animal hours.

Next to this operation in the number of hours consumed was the cultivation. The first cultivation, the "hilling-up", required 23.4 man hours and 23.4 animal hours. The second cultivation, "off-barring", required 86.4 man hours and 86.4 animal hours. The big difference

in the number of hours consumed was caused by the thick growth of weeds encountered in the second cultivation. The third cultivation required 30.5 man hours and 30.5 animal hours which was higher than that of the first but lower than the second. The weeds that were plowed under in the third cultivation were those that survived the second cultivation. The three cultivations required 140.3 man hours and 140.3 animal hours.

Planting was third as to the number of hours consumed in the operation. The preparation of cuttings required 45.4 man hours and 31.8 animal hours. The planting alone required 77.3 man hours. The total number of hours consumed was 122.7 man hours and 31.8 animal hours.

The first plowing which was done with the tractor required 7.8 hours only. The disc plow cut so deep that only two more plowings with the native plow were required to prepare the land. The second plowing required 56.5 man and 56.5 animal hours; the third plowing required 52.0 man and 52.0 animal hours.

Furrowing required 37 man and 37 animal hours which was more than double the harrowing requirement. Harrowing required 15.6 man and 15.6 animal hours.

Ratoon. Table 2 shows the number of hours required for the different operations for ratoon. It will be observed that four cultivations were necessary. The first cultivation, which was after burning the trash left in harvesting the plant canes, required 45.5 man and 45.5 animal hours. The soil was rather hard during the first cultivation. The second cultivation which was "hilling-up" required 23.4 man and 23.4 animal hours. At the third cultivation there was a thick growth of weeds so it required 49.4 man and 49.4 animal hours. The fourth and final cultivation required 27.3 man and 27.3 animal hours. The total number of hours required for cultivation was 145.6 man hours and 145.6 animal hours.

In harvesting, the ratoon required 59.7 man hours for topping, 89.6 man hours for cutting and 81.2 man and 81.2 animal hours for hauling.

Cost of different farm operations

Table 5 shows the cost of the different farm operations. Column 2 shows the cost per hectare for plant canes and column 3, the cost for ratoon. It may be seen that for plant canes harvesting involved the largest expenditure which was ₱73.21. With a production of 45.36

tons per hectare the cost of harvesting and hauling per ton of canes was ₱1.59. Column 3 shows that it cost ₱35.26 to harvest and haul the canes from one hectare of ratoon.

In hauling, including loading, Henry (1929)[2] found that the cost of transportation per ton kilometer of canes was ₱0.25 with the use of truck and trailer and ₱0.50 with the use of carabao cart. In the present study, using carabao cart, this item of cost was considerably higher, being ₱0.84 per ton kilometer.

In expense, plowing was second to harvesting. The plowing of the land cost ₱34.53 per hectare. It involved one tractor and two animal plowings. The harrowing cost ₱3.47 per hectare. The total cost of land preparation per hectare was ₱38.00. Locsin (1923)[3] found that the land preparation per hectare was ₱34.80. It involved five animal plowings and harrowings.

Cultivation cost ₱31.61 per hectare for plant cane and ₱32.76 for ratoon. It will be observed that the cost of cultivation for the ratoon was higher than for plant canes. This was because plant cane required three cultivations while the ratoon required four. The cost of cultivation for plant cane, as found in this study, is very much lower than Locsin (1923) found. He reported ₱51.60 per hectare, which included cost of hilling with shovel and hoe.

The cost of furrowing per hectare as shown in the same table (table 5) was ₱8.33 and the actual planting per hectare, ₱8.50. The actual cost of planting was higher than that found by Henry (1929) which was ₱6.25 to ₱7.50 per hectare and by Locsin (1923) which was ₱6.20.

The total cost per hectare of different farm operations as shown in table 5 was ₱168.53 for plant canes and ₱68.02 for ratoon.

Total cost of production per hectare

Table 6 shows the itemized and total cost of production. Column 2 shows the cost for plant canes when the canes were hauled from the field to the mill and column 3 shows the cost for ratoon. It will be observed that the labor cost for plant canes was ₱154.77 and ₱66.31 for ratoon. The depreciation and interest on the money invested on improvements was ₱5.94 for plant canes and ₱1.94 for ratoon. Land

[2] HENRY, IVES. 1928. Technical and financial conditions of production of sugar in the Philippines. Published by the General Government of Indo China, Hanoi. Translated from the French by Irwin McNiece, 1929. 109 p., 22 charts. Manila: Philippine Sugar Association.

[3] LOCSIN, CARLOS L. 1923. Cultivation of sugar cane in western Negros. Sugar Central and Planters News 4:part 2, p. 599 and part 3 p. 658-662.

and supply costs were ₱46.87 for plant canes and ₱20.00 for ratoon. The land rent was based on the local rental rate of ₱20.00 per hectare per year. The land was used for 14 months for plant canes and 12 months for ratoon. The cost of points was based on 28,000 per hectare at ₱6.00 per 10,000. The total cost of production was ₱207.58 for plant canes and ₱88.25 for ratoon.

Column 4 shows the itemized cost of production per hectare for plant canes and column 5 for ratoon when the harvested canes were piled in the field ready for hauling. For plant canes the different costs were ₱118.49 for labor, ₱3.97 for depreciation and interest, and ₱46.87 for land rent and supplies; the total was ₱169.33. For ratoon the labor cost was ₱48.45; depreciation and interest, ₱0.97; and land rent, ₱20.00; the total was ₱69.42.

Cost of production per ton of canes

Table 7 gives the cost of production per ton of canes. When hauling was included the cost was ₱4.57 for plant canes and ₱4.79 for ratoon. When hauling was excluded the cost was ₱3.73 for plant canes and ₱3.77 for ratoon. These figures were based on the actual production of 45.36 tons per hectare for plant canes and 18.43 tons for ratoon.

Cost of production per ton of canes delivered to Calamba Sugar Estate

Table 8 shows the cost of production per hectare with canes delivered to Calamba Sugar Estate. The cost of production per hectare, excluding hauling, was ₱169.33 for plant canes and ₱69.42 for ratoon. The cost of loading 45.36 tons which was the yield per hectare from plant canes was ₱6.00; and of 18.43 tons which was the yield from one hectare of ratoon was ₱2.45. The canes were loaded in trucks which transported them from the field to the College Station, a distance of about 2.2 kilometers.

The cost of transporting the canes from the field to College Station was ₱45.36 for plant canes and ₱18.43 for ratoon.

The cost of loading the canes on N. B. and J. P. cars was ₱22.68 for plant canes and ₱9.26 for ratoons. The above figures were furnished by Mr. Silvio Lopez who took charge of the work.

The total cost of production per hectare with canes delivered to Calamba Sugar Estate was ₱243.37 for plant canes and ₱99.56 for ratoon. Table 9 shows that the cost of production per ton of cane delivered to Calamba Sugar Estate was ₱5.37 for plant canes and ₱5.40 for ratoon.

Percentage return on the investment

Basing calculations on ₱6.00 as the selling price per ton, figures furnished by Mr. Lopez, the net profit per ton was ₱0.63 for plant canes and ₱0.60 for ratoon. The net profit per hectare, counting 45.36 tons as the production of plant canes was ₱28.58; and 18.43 tons for ratoon was ₱11.05. With a total cost of production of ₱243.37 for plant canes and ₱99.56 for ratoon, the percentage return on the investment was 11.47 per cent for plant canes and 11.11 per cent for ratoon.

SUMMARY

1. The cost of plowing one hectare preparatory to cane planting was ₱34.53. It involved one tractor plowing and two plowings with the native plow.

2. The cost of harrowing per hectare was ₱3.47. The native spike tooth harrow or *calmot* was used.

3. The furrowing cost was ₱8.33 per hectare. The depth of furrow ranged from 6 to 8 inches (15.24 to 20.32 centimeters). To attain this depth the plow was run through the furrow three times.

4. The total cost of planting per hectare including cost of preparing the points was ₱17.38.

5. A total of 28,000 points was planted to one hectare.

6. The cost of cultivating plant canes per hectare was ₱31.61. It involved three operations, first "hilling-up", second the "off-barring" and the third, "hilling-up" again.

7. The cost of cultivating the ratoon per hectare was ₱32.76. It involved four operations; first, "off-barring"; second, "hilling-up"; third, "off-barring"; and fourth, "hilling-up".

8. In the plant cane culture, practically no weeds were plowed under in the first cultivation, as few of the weed seeds had germinated. A thick growth of weeds was encountered in the second cultivation but fewer in the third.

9. Harvesting was the most expensive operation in the production of canes. It cost ₱73.21 per hectare for plant canes and ₱35.26 for ratoon.

10. The total production per hectare was 45.36 tons for plant canes and 18.43 tons for ratoon.

11. The cost of production per hectare with canes cut and ready for hauling was ₱169.33 for plant canes and ₱69.42 for ratoon. Including hauling it cost ₱207.58 for plant canes and ₱88.25 for ratoon.

12. The cost of producing one ton of plant cane cut and ready for hauling in the field was ₱3.73 and ₱4.57 when hauled to the U. P. Sugar Mill. For the ratoon, the cost of production per ton when cut and ready for hauling in the field was ₱3.77 and ₱4.79 when hauled to the College mill.

13. The cost of producing one ton of cane delivered to Calamba Sugar Estate was ₱5.37 for plant canes and ₱5.40 for ratoon.

14. The net gain per ton was ₱0.63 from plant canes and ₱0.60 from ratoon. It was based on ₱6.00 as the selling price.

15. The net income per hectare was ₱28.58 from plant canes and ₱11.06 from ratoon.

16. The percentage return on the investment was 11.74 per cent from plant canes and 11.11 per cent from ratoon.

TABLE 1

Labor cost for the different farm operations for plant canes

OPERATIONS	KIND OF LABOR	NUMBER OF HOURS		LABOR COST PER HECTARE
		For 1.54 hectare	Per hectare	
				pesos
Plowing:				
First with tractor	Man	12.0	7.8	1.25
Second with animal	Man	87.0	56.5	6.22
	Animal	87.0	56.5	6.22
Third with animal	Man	80.0	52.0	5.72
	Animal	80.0	52.0	5.72
Harrowing	Man	24.0	15.6	1.72
	Animal	24.0	15.6	1.72
Furrowing	Man	57.0	37.0	4.07
	Animal	57.0	37.0	4.07
Preparation of cuttings:				
Cutting of points	Man	21.0	13.6	1.50
Hauling	Man	49.0	31.8	3.50
	Animal	49.0	31.8	3.50
Planting	Man	119.0	77.3	8.50
Cultivation:				
Hilling-up	Man	36.0	23.4	2.57
	Animal	36.0	23.4	2.57
Off-barring	Man	133.0	86.4	9.51
	Animal	133.0	86.4	9.51
Hilling-up	Man	47.0	30.5	3.36
	Animal	47.0	30.5	3.36
Harvesting:				
Topping	Man	190.0	123.3	13.57
Cutting	Man	285.0	185.0	20.33
Hauling	Man	254.0	164.9	18.14
	Animal	254.0	164.9	18.14
				154.77

TABLE 2

Labor cost for the different farm operations for first ratoon canes

OPERATIONS	KIND OF LABOR	NUMBER OF HOURS For 1.54 hectare	NUMBER OF HOURS Per hectare	LABOR COST PER HECTARE
				pesos
Cultivation:				
Off-barring	Man	70.0	45.5	5.01
	Animal	70.0	45.5	5.01
Hilling-up	Man	36.0	23.4	2.57
	Animal	36.0	23.4	2.57
Off-barring	Man	76.0	49.4	5.43
	Animal	76.0	49.4	5.43
Hilling-up	Man	42.0	27.3	3.00
	Animal	42.0	27.3	3.00
Harvesting:				
Topping	Man	92.0	59.7	6.57
Cutting	Man	138.0	89.6	9.86
Hauling	Man	125.0	81.2	8.93
	Animal	125.0	81.2	8.93
				66.31

TABLE 3

Depreciation of implements and interest on the investment

KIND OF IMPLEMENT	COST	MAXIMUM NUMBER OF DAYS IN ONE YEAR	LIFE IN YEARS	ANNUAL RATE OF INTEREST	FOR 1.54 HECTARE								DEPRECIATION AND INTEREST PER HA.	
					Plant canes				Ratoon					
					Number of hours used	Depreciation and interest			Number of hours used	Depreciation and interest				
						Depreciation	Interest	Total		Depreciation	Interest	Total	Plant canes	Ratoon
	pesos			*per cent*		*pesos*	*pesos*	*pesos*		*pesos*	*pesos*	*pesos*	*pesos*	*pesos*
Tractor	1600	140	8	10	12	1.90	0.58	2.48					1.61	
Disc plow	347	100	8	10	12	0.58	0.13	0.71					0.46	
Native plow	17	100	4	10	440	2.08	0.23	2.31	224	1.06	0.12	1.18	1.50	0.97
Native harrow, *calmot* ..	5	100	4	10	24	0.04	0.004	0.044					0.03	
Bull cart	100	250	5	10	303	2.69	0.92	3.61	125	1.11	0.38	1.49	2.34	0.97
Total													5.94	1.94

TABLE 4

Land and supply costs

ITEMS	COST FOR 1.54 HECTARE		COST PER HECTARE	
	Plant cane	Ratoon	Plant cane	Ratoon
	pesos	*pesos*	*pesos*	*pesos*
Land rent [a]	35.91	30.80	23.32	20.00
Points	25.86		16.79	
Fuel for tractor:				
Gasoline	0.37		0.24	
Petroleum	6.72		4.36	
Lubricant:				
Oil	3.05		1.98	
Grease	0.27		0.18	
Total			46.87	20.00

[a] The land was used for 14 months for plant canes and 12 months for ratoon.

TABLE 5

Total cost for the different farm operations per hectare

OPERATIONS	PLANT CANE	RATOON
	pesos	*pesos*
Plowing	34.53	
Harrowing	3.47	
Furrowing	8.33	
Preparation of cuttings	8.88	
Planting	8.50	
Cultivation	31.61	32.76
Harvesting	73.21	35.26
Total	168.53	68.02

TABLE 6

Itemized cost of production per hectare

ITEMS	INCLUDING COST OF HAULING CUT CANES		EXCLUDING COST OF HAULING CUT CANES	
	Plant canes	Ratoon	Plant canes	Ratoon
	pesos	*pesos*	*pesos*	*pesos*
Labor cost	154.77	66.31	118.49	48.45
Depreciation and interest	5.94	1.94	3.97	0.97
Land and supply costs	46.87	20.00	46.87	20.00
Total	207.58	88.25	169.33	69.42

TABLE 7

Cost of production per ton of canes

CROP	COST OF PRODUCTION PER HA.		YIELD PER HA.	COST OF PRODUCTION PER TON	
	Including cost of hauling cut canes	Excluding cost of hauling cut canes		Including cost of hauling cut canes	Excluding cost of hauling cut canes
	pesos	*pesos*	*tons*	*pesos*	*pesos*
Plant canes	207.58	169.33	45.36	4.57	3.73
Ratoon	88.25	69.42	18.43	4.79	3.77

TABLE 8

Cost of production per hectare with canes delivered to Calamba Sugar Estate

ITEMS	PLANT CANES	RATOON
	pesos	*pesos*
Cost of production per hectare excluding cost of hauling ...	169.33	69.42
Cost of loading canes in trucks per hectare	6.00	2.45
Cost of transporting canes from field to College Station	45.36	18.43
Cost of loading canes on N. B. or J. P. cars	22.68	9.26
Total cost of production per hectare of canes delivered to Calamba Sugar Estate	243.37	99.56

TABLE 9

Cost of production per ton of canes delivered to Calamba Sugar Estate

CROP	TOTAL COST OF PRODUCTION PER HA.	PRODUCTION PER HA.	COST OF PRODUCTION PER TON
	pesos	*tons*	*pesos*
Plant canes	243.37	45.36	5.37
Ratoon	99.56	18.43	5.40

STUDIES ON THE CONSUMPTION OF SUGAR FOR ONE YEAR BY FIFTY FILIPINO FAMILIES IN CALAUAN, LAGUNA [1]

JOSÉ C. ATIENZA

In the Philippines, as in other countries, the amount of sugar that is used by the population is gauged by the per capita consumption. The per capita consumption, however, is only a statistical figure, and as such, can hardly be taken to represent the actual consumption. Writing on this subject, Mayo (1928) [2] stated, "that reported statistics of consumption represent really, not consumption, but distribution. Of course the sugar distributed through trade channels is consumed ultimately, but it may or may not be consumed during the year in which its distribution takes place, and the weight of evidence is that apparent fluctuations in consumption from year to year are due to vagaries in the trade movement of sugar." Then there is also the so-called invisible supply, the surplus stock carried over from year to year, there being no actual data on this, the statistician must base his calculations upon estimates which of course vary in accuracy. There are also a number of other factors which render the per capita consumption figure of very dubious value.

Just how much sugar then, does an average Filipino consume? A study of the consumption of sugar as it actually enters the diet of the people might give a fairly correct answer to this question. It might also be of help in ascertaining the possibilities of increasing our sugar consumption by nation wide propaganda, an undertaking recently began by the Philippine Sugar Association.

The object of the present work was to study for a period of one year, from April, 1930 to April, 1931 the consumption of sugar, as it actually entered into the diet of fifty average Filipino families living in Calauan, Laguna.

The analytical phase of the study was performed in the advanced laboratory of the Department of Agricultural Chemistry, College of Agriculture.

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[1] Experiment Station contribution No. 901. Part of thesis, No. 356, presented in 1932. Prepared in the Department of Agricultural Chemistry under the direction of Dr. Francisco O. Santos. Received for publication, May 24, 1933.

[2] MAYO, E. W. 1928. Are women eating less sugar? Facts About Sugar **23**: 560.

MATERALS AND METHODS

The different kinds of sugar consumed by the fifty families during the study were analyzed for sucrose. There were twenty-three different samples. These included six kinds of sugar, four kinds of locally made sweets, twelve kinds of candies and one brand of sweetened condensed milk.

Walker's inversion method for sucrose determination, as given in *Chemical Control for Cane Sugar Factories of the Association of Hawaiian Sugar Technologists,* (1924)[3] was adopted in the analysis of the different kinds of sugar.

In the analysis of five of the samples, this method was modified on account of the peculiar constituents of these samples. The modification consisted of using the method worked out by Stokes and Bodmer for sucrose determination in sweetened condensed milk, as described by Leffmann and Beam (1906)[4].

From five to six sucrose determinations were made of each of the twenty-three samples.

The statistical phase of the study

Subject of the study. Fifty Filipino families of moderate means, so chosen as to represent fairly any typical Philippine community, constituted the subjects of this study.

Collection of primary data. Records of the quantity of sugar and other food articles containing sugar consumed every day were kept by each of the fifty families under study, for a period covering 52 weeks. These records were collected by the writer at the end of every week. It may be stated here that the kind coöperation of these families made the securing of authentic data possible.

Methods of recording consumption. Various ways were employed to ascertain the quantity consumed. In most cases the weight of the material as bought and weighed on the scale in the retail stores was recorded by the family. Those who bought sugar reckoned by cost as so many centavos worth instead of by kilograms recorded their daily consumption in terms of centavos. Some used cups to measure the volume of sugar as it was being used and then recorded consumption by the number of cups, and still others took count of

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[3] ANONYMOUS. 1924. Chemical control for cane sugar factories. 114 p., 10 fig. Honolulu: The Association of Hawaiian Sugar Technologists.

[4] LEFFMANN, A. M., AND WILLIAM BEAM. 1906. Food analysis. VI + 396 p., 55 fig. Philadelphia: P. Blakiston's Son and Company.

the number of spoonfuls of sugar used from day to day. Sugar food commodities which are bought by the piece, like panocha, caramelo, pilon cubes, sweets and candies, were recorded by the number of pieces. Whatever plan was followed in keeping track of consumption, the quantities were finally reduced to their weights in grams by a system of equivalents devised by the writer.

Consumption always charged to the consumer. Consumption was always strictly charged to the consumer. If, for any reason, consumption could not be properly accounted for, the consumption data of the week which included the faulty record was discarded. For example, it not infrequently happened, during the period of 52 weeks that a social activity of some kind in the household brought about unusually large purchases of sugar which obviously could not have been consumed by the members of the family alone. As such a circumstance made the taking of correct data for the family impossible, because of the abnormal consumption, these data were not considered in the calculations. As a rule, any condition that would alter the normal economy of the household, so as to make consumption not accountable, was considered as warranting the discarding of such record.

Other data collected. Besides the data on consumption, the following were also taken: (1) the number of persons (not infants) in the family, (2) estimated income of the family, (3) means of living of the family and the (4) retail price of sugar from week to week.

RESULTS AND DISCUSSION

From the primary consumption data and other accessory data collected, and the results of the laboratory analyses, the following were determined: (1) the quantity of sugar consumed by each of the fifty families for one year, raw and refined value; (2) the total quantity of sugar consumed by the fifty families in one year, raw and refined value; (3) the per capita consumption, raw and refined values, by each of the fifty families; (4) the overall per capita consumption of the fifty families, raw and refined values; (5) the relative amounts of the different forms of sugars consumed during the study.

Whatever relation income and the price of sugar may bear to the per capita consumption was also ascertained.

The results of the study may be seen in tables 1 to 6.

The sugar consumption of the fifty families (table 4) ranged from 6.317 to 24.031 kgm., refined value or 6.493 kgm., to 25.025 kgm., raw value. Eight families had a per capita consumption of from 6 to 10 kgm.; eight families, from 10 to 14 kgm., nineteen families, from 14 to 18 kgm.; eleven families, from 18 to 22 kgm.; and four families from 22 to 25 kgm.; all refined value. The total sugar consumption of fifty families composed of 421 individuals, 252 of whom were adults and 169, children (not infants), for one year, was 6763 .252 kgm., raw value, or the equivalent 6362.326 kgm., refined value. This represents an overall per capita consumption of 16.604 kgm. raw value, or 14.416 kgm. refined value. This figure is much greater than the per capita sugar consumption as produced by statistics for the Philippines, which is only 9.7 kgm.

The per capita consumption and the income

Table 5 shows that family 23 with an income of 1000 pesos had a per capita consumption of 24.031 kgm., whereas family 13 with an income of 4,800 pesos had a per capita consumption of 16.684 kgm. only. Family 30 with an income of 360 pesos had almost the same per capita consumption as family 39 with an income of 600 pesos. Family 50 whose income was two and a half times that of family 37 had a per capita consumption about 5 kgm. less. It is generally supposed that the consumption of sugar is largely influenced by the ability to obtain it. Within the limits of income differences among the fifty families studied, the ability to buy does not seem to be a very important factor. Of the fifty families, the consumption of the poorer ones was just as great per capita and sometimes greater than the more well-to-do ones. Consumption appears to be more a matter of the habit of the individual or individuals.

On an average, an income of 836.08 pesos, for a family represented a per capita consumption of 16.604 kgm. of sugar, raw value, or 14.416 kgm. sugar, refined value. Twenty-three of the fifty families belong to the farming class, 14 to the employee's class, 9 to the laboring class, and 3 to the business class. It appears from table 5 that families of sedentary occupation consume as much sugar as those physically active.

Of the total amount of sugar that was consumed by the fifty families for one year (table 6) 52.99 per cent was granulated refined sugar, 27.66 per cent was the commercial centrifugal sugar, 9.11 per cent was the panocha turned out by the native antiquated mills, 0.5 per cent was the pilon lump sugar, and 9.74 per cent was the aggregate of all kinds of locally made sweets and candies.

The retail price of the refined and commercial sugar, as bought by the families under study, fluctuated during the period of the study within two centavos per kgm. The cost of the locally made sweets and candies remained constant. The consumption of sugar by each of the fifty families was almost steady from week to week. Apparently, price was not a factor in sugar consumption.

SUMMARY

1. The per capita consumption of the fifty families ranged from 6.317 kgm. to 24.031 kgm. sugar refined value, or 6.493 kgm. to 25.027 kgm. raw value.

2. The overall per capita consumption of the fifty families was 16.604 kilograms raw value, or 14.416 kilograms refined value.

3. The consumption of sugar in each family was steady throughout the year. Within the limits of the changes in the costs of sugar during the period of the study, price was not a factor in sugar consumption.

TABLE 1

Showing the consumption of different forms of sugar by fifty Filipino families for one year, raw value

FAMILY	CONSUMPTION									TOTAL FOR EACH FAMILY
	Refined sugar	Commercial sugar	Pilon sugar	Panocha	Panochitas	Caramelos	Balikutsa	Bukayo	Candies and others	
	kgm.	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*
1	13.830	96.156	3.946	17.927	6.510	3.440	3.105	—	—	144.914
2	55.000	2.108	—	10.995	8.335	1.543	1.215	4.859	29.418	113.473
3	14.330	103.960	—	9.802	7.476	2.639	5.175	6.770	—	150.152
4	199.790	19.000	7.917	32.905	8.919	6.494	4.515	6.497	—	286.037
5	163.960	—	4.651	20.619	7.508	2.247	1.500	3.450	26.604	230.542
6	20.750	171.500	—	11.680	6.075	4.448	5.295	8.040	—	227.788
7	162.300	—	8.840	6.780	—	—	—	—	—	177.950
8	—	125.200	—	14.778	6.526	4.616	6.390	6.217	—	163.727
9	—	38.885	—	9.442	3.681	1.176	3.375	3.377	—	59.936
10	86.250	10.500	4.862	7.702	—	—	—	—	—	109.314
11	45.891	23.731	—	15.197	4.799	3.550	2.820	2.345	—	98.333
12	114.500	21.160	—	19.524	12.961	2.750	4.245	5.316	—	180.356
13	90.500	33.500	—	9.530	6.158	2.544	3.825	4.079	48.505	198.641
14	155.400	5.330	—	7.641	4.710	3.896	3.540	3.359	3.492	187.368
15	76.259	21.850	—	12.684	6.946	4.458	4.035	4.625	—	130.857
16	—	81.803	—	11.413	10.327	4.603	4.830	6.849	5.998	125.023
17	62.451	—	—	7.403	4.532	2.795	2.130	3.533	—	82.844
18	95.000	—	—	7.907	—	4.997	—	—	—	105.904
19	—	59.770	—	8.048	4.224	1.995	3.938	5.016	—	73.991
20	81.583	33.977	—	8.615	9.709	2.890	4.035	4.450	3.564	148.823
21	45.795	26.685	—	10.118	9.366	5.371	5.035	3.181	—	105.551
22	94.918	—	—	13.350	—	—	—	—	—	108.268
23	170.000	—	—	11.279	4.977	4.366	2.520	5.927	0.751	197.820
24	70.096	47.818	—	9.565	8.308	4.242	4.665	5.309	—	150.003
25	36.098	—	—	11.870	3.843	1.886	—	—	—	53.697
26	4.249	36.273	—	9.152	2.979	1.037	—	—	—	53.690
27	81.215	—	—	10.270	3.959	1.508	0.870	2.439	1.649	107.910
28	136.049	17.726	—	21.933	8.393	2.089	2.295	2.829	2.882	194.196
29	—	49.144	—	9.293	—	—	—	—	—	58.437
30	64.295	—	—	8.944	—	—	—	—	—	73.239
31	23.169	79.756	—	13.309	5.785	2.402	3.480	5.956	—	133.857
32	76.461	41.378	—	16.870	10.905	4.514	5.373	6.890	7.325	169.716
33	146.115	10.000	—	24.480	11.438	3.230	5.310	5.482	—	206.055
34	81.325	—	—	8.193	—	—	—	—	—	89.518
35	80.000	30.000	—	14.368	—	—	—	—	—	124.368
36	75.415	34.250	—	14.457	10.276	1.180	1.290	2.555	40.423	179.846
37	9.000	79.831	—	9.107	6.419	2.844	3.315	2.753	—	113.269
38	59.264	39.000	—	11.350	—	—	—	—	—	109.614
39	64.750	—	—	12.198	6.197	2.861	3.900	4.588	0.565	95.059
40	55.376	—	—	19.952	7.019	2.860	4.035	4.664	—	93.906
41	85.747	14.750	3.328	11,220	6.948	2.984	3.030	5.760	—	133.767
42	39.328	62.914	—	11.776	7.156	4.163	3.735	6.011	4.916	139.999
43	55.769	18.500	—	11.270	6.766	3.408	1.230	2.616	23.055	122.614
44	24.533	81.800	—	8.205	4.427	2.416	3.820	5.602	—	130.803
45	130.518	4.028	—	15.484	11.704	2.857	6.450	7.334	11.820	190.195
46	66.957	2.763	—	10.075	7.959	3.739	4.440	5.561	—	101.499
47	57.965	—	—	13.335	6.316	3.187	3.225	3.281	34.220	90.781
48	—	159.666	—	15.522	5.017	10.493	4.380	3.455	—	198.533
49	101.678	—	—	7.446	—	—	—	—	—	109.124
50	100.000	104.559	—	10.538	6.437	—	3.825	5.835	—	131.194
Total for each kind of sugar	3371.909	1780.276	33.547	631.522	281.890	134.718	140.191	174.810	214.389	6763.252

TABLE 2

Showing the sucrose content of the different forms of sugar consumed

KIND OF SUGAR	WT. PER PIECE	SUCROSE	EQUIVALENT 100° SUGAR
	grams	*per cent*	*grams*
Refined sugar	——	100.00	100.00
Commercial sugar	——	98.25	98.25
Pilon lump sugar	13.0	95.06	12.35
Panocha (1)	130.5	91.95	119.99
Panocha (2)	92.0	91.95	84.59
Panochitas	20.3	67.66	13.73
Caramelo	15.7	96.20	15.10
Balikutsa	15.0	85.78	12.88
Bukayo	19.5	36.53	7.11
Coco-caramel	8.9	86.06	7.66
Lemon candies	4.3	98.14	4.22
Lemon drops	1.3	95.73	1.24
Stick candy	6.4	54.43	3.48
Rock candy (1)	8.2	98.95	8.11
Rock candy (2)	11.5	96.12	11.05
Lollypops	9.4	98.77	9.28
Chocolate candy (1)	4.5	36.50	1.64
Chocolate candy (2)	9.0	34.00	3.06
Milk candy (1)	8.1	43.61	3.53
Milk candy (2)	3.4	74.18	2.52
Belecoy	13.7	39.71	5.45
Liñga	4.1	23.85	0.98
Sweet condensed milk [a]	435.0	42.00	182.70

[a] The weight indicated is the weight per can.

TABLE 8

Showing the consumption of different forms of sugar by fifty Filipino families for one year, refined value

FAMILY	CONSUMPTION									TOTAL FOR EACH FAMILY
	Refined sugar	Commercial sugar	Pilon sugar	Panocha	Panochitas	Caramelos	Balikutsa	Bukayo	Candies and others	
	kgm.	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*
1	13.830	94.421	3.753	16.493	4.401	3.309	2.664	—	—	138.871
2	55.000	2.073	—	10.115	5.634	1.484	1.042	1.774	14.124	91.246
3	14.330	102.193	—	9.018	5.054	2.528	4.440	2.971	—	140.534
4	199.790	18.677	7.529	30.273	6.029	6.247	3.874	2.371	—	274,790
5	163.960	—	4.426	18.969	5.075	2.062	1.287	1.287	13.989	211.027
6	20.750	168.585	—	10.746	4.107	4.279	4.543	3.935	—	216.945
7	162.330	—	8.407	6.239	—	—	—	—	—	176.976
8	—	123.072	—	13.596	4.412	4.441	5.483	2.209	—	153.213
9	—	38.224	—	8.687	2.488	1.131	2.896	1.233	—	54.000
10	86.250	10.322	4.628	7.086	—	—	—	—	—	108.28
11	45.891	23.328	—	13.981	3.244	3.415	2.419	0.856	—	93.134
12	114.500	20.800	—	17.962	8.694	2.646	3.642	1.940	—	170.184
13	90.500	32.931	—	8.768	4.163	2.447	3.282	1.489	23.260	166.840
14	155.400	5.239	—	7.030	3.184	3.748	3.037	1.226	2.374	181.239
15	76.259	21.479	—	11.669	4.695	4.289	3.462	1.659	—	123.512
16	—	80.412	—	10.500	6.981	4.428	4.144	2.500	4.079	113.044
17	62.451	—	—	6.811	3.064	2.689	1.827	1.290	—	78.132
18	93.000	—	—	7.274	—	4.807	—	—	—	105.081
19	—	49.907	—	7.464	2.855	1.919	3.379	1.831	—	67.295
20	81.583	33.399	—	7.926	3.563	2.870	3.462	1.624	2.424	139.761
21	45.795	26.231	—	9.308	6.331	5.167	4.320	1.161	—	98.313
22	94.918	—	—	12.282	—	—	—	—	—	107.200
23	170 000	—	—	10.377	3.365	4.200	2.162	1.433	0.718	193.255
24	70.096	47.005	—	8.300	5.606	4.081	4.006	1.938	—	141.532
25	36.098	—	—	10.920	2.598	1.814	—	—	—	51.430
26	4.249	35.656	—	8.420	2.014	0.997	—	—	—	51.336
27	81.215	—	—	14.968	2.676	1.451	0.746	0.890	1.121	103.085
28	136.049	17.425	—	20.178	5.673	2.009	1.969	1.023	2.958	187.084
29	—	48.308	—	8.549	—	—	—	—	—	56.857
30	64.295	—	—	8.228	—	—	—	—	—	72.523
31	23.969	78.400	—	12.244	3.910	2.311	2.986	21.740	—	125.194
32	76.461	40.674	—	15.520	7.372	4.342	4.610	2.515	4.981	156.475
33	146.115	9.830	—	22.522	7.732	3.107	4.556	2.001	—	195.863
34	81.325	—	—	7.537	—	—	—	—	—	88.862
35	80.000	29.490	—	13.228	—	—	—	—	—	122.718
36	75.415	33.668	—	13.000	6.946	1.135	1.107	0.933	19.779	152.283
37	9.000	78.474	—	7.478	4.339	2.736	2.844	1.005	—	105.876
38	59.264	38.337	—	10.442	—	—	—	—	—	108.043
39	64.750	—	—	11.222	4.189	2.752	3.346	1.675	0.486	88.420
40	55.376	—	—	18.356	4.745	2.751	3.462	1.702	—	86.392
41	85.747	14.499	3.165	10.322	4.697	2.871	2.599	2.102	—	126.002
42	39.328	61.844	—	10.834	4.847	4.005	3.205	2.199	3.343	129.605
43	50.769	18.175	—	10.368	4.574	3.278	1.055	0.955	8.223	102.397
44	24.533	80.409	—	7.549	2.993	2.324	3.277	2.045	—	123.130
45	130.518	3.959	—	14.245	7.912	2.748	5.534	2.677	8.038	175.625
46	66.957	2.711	—	9.269	5.360	3.597	3.809	2.030	—	93.733
47	57.965	—	—	12.268	4.270	3.066	2.767	1.198	3.316	33.116
48	—	156.951	—	14.280	3.391	10.093	3.758	1.261	—	189.734
49	101.678	—	—	6.850	—	—	—	—	—	108.528
50	—	102.781	—	9.695	4.351	2.129	3.281	2.129	—	122.237
Total for each kind	3371.909	1749.889	31.908	580.106	190.534	129.484	120.282	65.207	113.013	6362.326

TABLE 4

Showing the total and the per capita consumption of sugar by each of the fifty Filipino families for one year, raw and refined values, and their averages

FAMILY	NUMBER			TOTAL CONSUMPTION, RAW VALUE	PER CAPITA CONSUMPTION, RAW VALUE	TOTAL CONSUMPTION, REFINED VALUE	PER CAPITA CONSUMPTION, REFINED VALUE
	Adults	Children	Total				
				kgm.	*kgm.*	*kgm.*	*kgm.*
1	5	3	8	144.914	18.114	138.871	17.358
2	3	2	5	113.473	22.694	91.246	18.249
3	6	0	6	150.152	25.025	140.534	23.422
4	9	3	12	286.037	23.836	274.790	22.899
5	4	9	13	230.542	17.741	211.027	16.232
6	8	6	14	227.788	16.270	216.945	15.496
7	7	2	9	177.951	19.772	176.976	19.664
8	4	3	7	163.727	23.389	153.213	21.887
9	4	1	5	59.936	11.987	54.659	10.931
10	4	1	5	109.314	21.862	108.286	21.657
11	2	4	6	98.330	16.388	93.134	15.522
12	8	0	8	180.356	22.544	170.184	21.273
13	6	4	10	198.641	19.864	166.840	16.684
14	5	3	8	187.368	23.421	181.239	22.654
15	4	4	8	130.857	18.694	123.512	15.439
16	4	4	8	125.823	15.728	113.044	14.130
17	3	9	12	82.844	6.903	78.132	6.511
18	6	1	9	105.904	15.129	105.081	15.011
19	5	3	8	73.991	9.249	67.295	8.412
20	7	2	9	148.823	16.535	139.761	15.529
21	5	4	9	105.551	11.727	98.313	10.923
22	4	1	5	108.268	21.653	107.200	21.440
23	7	1	8	197.820	24.727	192.255	24.031
24	6	4	10	150.003	15.000	141.532	14.153
25	3	0	5	56.697	17.899	51.430	17.143
26	4	2	6	53.690	8.948	51.336	8.557
27	2	7	9	107.910	11.990	103.085	11.453
28	5	5	10	194.196	19.419	187.084	18.708
29	5	4	9	58.437	6.493	56.857	6.317
30	4	5	9	73.239	8.137	72.523	8.085
31	5	3	8	133.857	18.732	125.194	15.649
32	6	3	9	169.716	18.857	156.475	17.386
33	5	5	10	206.055	20.605	195.863	19.586
34	3	4	7	89.518	14.953	88.862	12.694
35	6	4	10	124.368	12.437	122.718	12.272
36	4	6	10	179.846	17.984	152.283	15.228
37	4	3	7	113.269	16.181	105.876	15.125
38	3	3	6	109.614	18.269	108.043	18.007
39	4	6	10	95.059	9.506	88.420	8.842
40	6	3	9	93.906	10.456	86.392	9.599
41	6	1	7	133.767	19.109	126.002	18.000
42	5	4	9	139.999	15.555	129.605	14.400
43	6	0	6	122.614	20.338	102.397	17.066
44	6	1	7	130.803	18.686	123.130	17.590
45	4	7	11	190.195	17.290	175.625	15.965
46	5	2	7	101.499	14.499	93.733	13.247
47	3	4	7	90.731	12.961	84.850	12.121
48	5	5	10	198.533	19.853	189.734	18.973
49	10	3	13	109.124	8.398	108.528	8.348
50	7	5	12	131.194	10.932	122.237	10.186
Total average	252	169	421	6763.252	16.604	6362.326	14.416

TABLE 5

Showing the estimated income of the fifty Filipino families and their per capita sugar consumption

FAMILY	OCCUPATION	PER CAPITA CONSUMPTION	ESTIMATED INCOME
		kgm.	*pesos*
1	Farmer	17.358	600.00
2	Office work	18.249	1200.00
3	Office work	23.422	800.00
4	Farmer	22.899	720.00
5	Mechanic	16.323	600.00
6	Merchant	15.496	850.00
7	Farmer	19.664	600.00
8	Farmer	21.887	950.00
9	Office work	10.931	720.00
10	Office work	21.657	960.00
11	Barber	15.522	500.00
12	Farmer	21.273	1000.00
13	Farmer	16.684	4800.00
14	Office work	22.654	2040.00
15	Laborer	15.439	480.00
16	Laborer	14.130	660.00
17	Farmer	8.690	500.00
18	Farmer	15.011	800.00
19	Farmer	8.412	850.00
20	Office work	15.529	600.00
21	Barber	10.923	500.00
22	Office work	21.440	1200.00
23	Farmer	24.031	1000.00
24	Farmer	14.153	500.00
25	Farmer	17.143	900.00
26	Farmer	8.557	400.00
27	Merchant	11.453	720.00
28	Farmer	18.708	1200.00
29	Office work	6.317	480.00
30	Laborer	8.085	360.00
31	Office work	15.649	600.00
32	Farmer	17.386	480.00
33	Merchant	19.586	1000.00
34	Farmer	12.694	480.00
35	Laborer	12.272	500.00
36	Office work	15.228	900.00
37	Laborer	15.125	400.00
38	Office work	18.007	720.00
39	Farmer	8.842	600.00
40	Laborer	9.599	500.00
41	Office work	18.000	840.00
42	Farmer	14.400	600.00
43	Farmer	17.066	1500.00
44	Office work	17.590	850.00
45	Farmer	15.965	600.00
46	Farmer	13.247	600.00
47	Farmer	12.121	480.00
48	Farmer	18.973	1000.00
49	Carpenter	8.348	700.00
50	Office work	10.186	1000.00
Average		14.416	836.08

TABLE 6

Showing the relative amounts of the different forms of sugar consumed by fifty Filipino families for one year, refined value

FORM OF SUGAR	QUANTITY CONSUMED	
	kgm.	*per cent*
Refined sugar	3371.909	52.99
Commercial sugar	1749.889	27.66
Pilon sugar	31.908	0.50
Panocha	580.106	9.11
Panochitas	190.534	2.99
Caramelos	129.484	2.03
Balikutsa	120.282	1.89
Bukayo	65.207	1.03
Candies and others	113.013	1.80
Total	6352.332	100.00

HENS AND PULLETS AS SOURCES OF EGGS FOR FOUNDATION STOCKS [1]

CONRADO B. UICHANCO

One of the poultryman's greatest concerns in the improvement of his flock is the proper selection of his foundation stock. For a long time, how long no one knows, selection for improvement, not only in poultry, but also in other classes of live stock, has been emphasized, even in the less advanced countries of the world. The earliest actual reference to poultry states that the Chinese Emperor, Fu-Hsi, who lived from 3341 to 3227 B. C., taught his people to breed fowls (Lippincott, 1927).

It has often been argued that hens are better than pullets as the source of eggs for the foundation stock. But some poultry breeders contend that pullets are better than hens in this respect. This study was undertaken to find out which of these assertions is applicable to the Los Baños Cantonese breed.

REVIEW OF LITERATURE

Richardson (1925) reported that ninety-five per cent of the commercial poultrymen in New Hampshire use pullets exclusively as breeders. Hays (1928) observed from results obtained with Rhode Island Reds that yearling hens gave a slightly higher percentage of hatchability than pullets. According to Stewart and Atwood (1909), two- and three-year-old White Leghorn hens gave better results than pullets in respect to percentage of eggs hatched, average size of chicks, and percentage of chick mortality. Kempster (1921) reported that White Leghorn hens gave a hatchability 4 per cent greater than the pullets.

Lippincott (1927) stated that in selecting eggs for hatching purposes, by far the most important consideration is the health and vigor of the parent stock. Pearl (1923), reasoning from the biology of poultry on the one hand, and of duration of life through his extensive studies on the other, stated, "If I were in a position to do so I should like to try, for a period of years, the experiment of breeding each

[1] Thesis presented for graduation, 1933, with the degree of Bachelor of Science in Agriculture from the College of Agriculture No. 357; Experiment Station contribution No. 902. Prepared in the Department of Animal Husbandry under the direction of Dr. F. M. Fronda.

year the oldest hens which could be had, and from which it was possible to get any chicks at all. To insure a reasonable degree of fertility, I should use younger male birds. Such offspring as were obtained would be kept as a wholly separate flock and line bred, working in all the time as much high longevity blood as possible." He figured out that after about five years, he would have a flock of astonishingly strong constitution, extremely low chick mortality, and probably high egg production.

Waite (1929) stated that the second year of production is recognized as a much more favorable age for breeding purposes than the pullet year, because the birds have already had the opportunity to exhibit their qualities as layers, so that only the best and most vigorous birds may be selected. Commenting on the theory that pullets are more satisfactory breeders than hens on account of their youth and vigor, he stated that although this may be true, there may be some disadvantages that far outweigh any advantages of youthful vigor, inasmuch as pullets as a rule do not lay large eggs, and small eggs do not hatch into large chicks. Also, according to Jull (1930), chicks from yearling hens are nearly always larger than those from pullets, since yearling hens lay larger eggs than pullets, there being a definite relationship between the size of the egg and the size of the chick, as found by Jull and Quinn (1925) and Upp (1928).

OBJECT OF PRESENT WORK

The object of this experiment was to compare hens and pullets as sources of eggs for foundation stocks. The Los Baños Cantonese breed was used, because it is at present recommended as the best breed of chickens that has been adapted to Philippine conditions (Fronda, 1924).

TIME AND PLACE OF PRESENT WORK

The work was begun on September 1, 1931, and closed on October 11, 1932. It was conducted in the Department of Animal Husbandry, College of Agriculture, Los Baños, Laguna.

MATERIALS AND METHODS

Stock. The original stock used in this experiment consisted of 100 hens and 100 pullets. The hens used were over two years old. When the eggs for the first hatch were collected, the pullets were 10 months old; for the second hatch, 12 months old; and the third hatch, 14 months old. The birds were kept in separate pens. Clean water and dry mash were available at all times of the day, and wet mash

was given at nine o'clock daily. The mash feed consisted of two parts by weight of dried shrimps, one part corn meal, three parts copra meal, and four parts rice bran. A grain mixture of one part cracked corn and one part palay was fed early in the morning and late in the afternoon. The birds were trapnested every two hours.

Four weeks prior to the collection of eggs for hatching, the roosters that were running with the flocks were removed. Eight selected Cantonese roosters of the same age were equally distributed at random to the two pens one week before the collection of the eggs that were hatched. Alternate mating was followed to make conditions in both pens more nearly identical. The roosters in both pens were interchanged every evening, thus precluding the possibility of accounting for the greater number of infertile eggs, dead germs, weak chicks, etc., produced in any lot by the roosters used.

Hatching. The eggs collected for hatching were held for not more than ten days, as recommended by Leoncio (1924). Careful attention was given to the size, shape, and texture of the shells of the eggs used. An equal number of eggs was selected daily from each lot. Each selected egg was identified with a number marked with a lead pencil on the blunt end, from 1 to 400. The weights of the eggs were taken on a Cenco trip balance (accurate to 0.1 gram), and recorded in a notebook with their corresponding serial number. There were three hatches made; the first hatch was taken off the incubator on December 25; the second on February 13; and the third on April 11. A 600-egg Buckeye kerosene-burning hot-water incubator was used in incubating the eggs.

Testing was done after the first and second weeks each time, the usual procedure being followed. In doubtful cases, the eggs were marked with a "D", returned to the incubator, and observed again in the following candling. The results of these candling tests were checked by opening the eggs after the candling operations.

On the eighteenth day of incubation, each egg was separately placed in a *sinamay* pedigree bag approximately 12 cm. by 18 cm., and labeled with numbers corresponding to those on the blunt end of each egg. To prevent the chicks from getting out, the free ends of the bags were held together with safety pins. At the end of the hatch, the number of eggs that failed to hatch, the pipped, and the cripples in both lots were separately recorded.

The newly hatched chicks were leg-banded and weighed soon after normal drying. The leg-band number and the corresponding serial number of the egg from which the chick was hatched were noted for identification purposes. The chicks were taken down from

the incubator on the twenty-second day and placed under a Buckeye charcoal-burning brooder in a colony brooder house where the chicks always had access to clean drinking water and green grass. A mash mixture consisting of the regular "2-2-6 chick ration" of two parts shrimp meal, two parts corn meal, and six parts rice bran, by weight, and a grain ration of corn meal were given to the chicks.

Weighing. The chicks were weighed on an arm balance, weekly for the first twelve weeks, and every two weeks thereafter until at the close of the experiment, when a spring balance was used.

Separation of the sexes and culling. The males and females were separated at the end of the twelfth week. After the sex and corresponding number had been recorded, the males were discarded.

Culling was also done at this period. In culling, particular attention was given to size, health and vigor, length and width of back, depth of body, width of the span, handling quality, color of the comb and wattles, pigmentation, and general conformation, rather than to plumage color and other breed and varietal characteristics. The number of culls in each lot was recorded.

Maturity. After the fourth month, the birds were transferred to a pen provided with trapnests. The "2-2-6 chick ration" was changed to the College mash mixture No. 2 (2-1-3-4) consisting of two parts shrimp meal, one part corn meal, three parts copra meal, and four parts rice bran.

The date of laying of the first egg by each bird that laid before the sixth month was recorded. The first ten eggs of each individual bird were weighed on an arm balance, and the weights were carefully recorded in a notebook.

RESULTS AND DISCUSSIONS

Weight of the eggs set. By reference to table 1, it may be noted that in the first two trials made, the hens' eggs were heavier than the pullets' eggs, but in the last hatch, the pullets' eggs were slightly the heavier. This result may be explained by the fact that at the time the first hatch was made, most of the pullets had just begun to lay, hence the presence of many small eggs in the pullets' lot. By the time the third hatch was made, most of the pullets had been laying for some time, so that the size of the eggs produced had become larger than the earlier ones. It is a matter of common observation that the first egg produced by a pullet is small; it gradually increases to the normal size as the bird continues to lay.

A statistical study of the average of the three trials from the standpoint of the probable error of the mean, showed a significant

difference in the weights of the eggs produced by the hens and those produced by the pullets. The average weight of the hens' eggs from the three trials was 43.4 ± 0.1068 grams; for the pullets' lot, the average weight of the eggs was 42.1 ± 0.0975 grams. The difference between the two means is 1.2660 ± 0.1445 grams, which is 8.75 times its probable error, showing that hens' eggs were definitely larger.

An examination of the eggs used in the first two sets revealed that there was a wider range of variability in the weight of the pullets' eggs set, than in the hens' eggs. This result was because some of the pullets had just started laying, while others had been laying for some time. The size distribution of the eggs used in the third set showed that there was a close similarity between the hens' eggs and the pullets'. By this time, all of the pullets had been laying for some time, so the eggs were fairly uniform.

Fertility. Referring to table 1 again it may be noted that in all of the three hatches made, there were more infertiles in the hens' lot than in the pullets'. This higher percentage of fertility of the pullets' eggs consistently appearing in all trials leaves no doubt that in fertility the pullets' eggs were better than the hens'. When the total percentage of the fertility in all the sets was considered, it was found that the pullets averaged 7.4 per cent better than the hens in this respect.

Dead germs: First week. As may be seen from table 1, 9.5 per cent of the eggs from the hens' lot had dead germs at the end of the first week, while for the pullets' lot, there was only 4.0 per cent, when the first hatch was made. In the second hatch, the hens had 4.5 per cent dead germs, the pullets, 5.5 per cent. In the third and last hatch, 13.5 per cent of the hens' eggs had dead germs, while in the pullets' lot, there was 16.0 per cent. An average of the three trials showed that the mortality for the first week in the hens' lot was 9.1 per cent; in the pullets' lot, the mortality was 8.5 per cent, the difference being 0.6 per cent.

Second week. Table 1 also shows that during the second week of incubation, in the first hatch, there was 3.0 per cent dead germs from the hens' lot, and 2.0 per cent from the pullets' lot. In the second trial, there was 7.0 per cent dead germs from the hens' eggs and 2.5 per cent from the pullets'. In the last trial, 8.0 per cent of the eggs from the hens' lot had dead germs, and 10.5 per cent from the pullets' lot. An aggregate of the three trials showed that there were 6.0 per cent dead germs from the hens' lot and 5.0 per cent for the pullets' lot, the difference being only 1.0 per cent.

Third week. By reference to table 1, it may be seen that for trial 1, there were 7.5 per cent dead germs from the hens' lot and 5.5 per cent from the pullets' lot. In the second hatch, there were 8.0 per cent dead germs from the hens' lot, and 6.0 per cent from the pullets' lot. For the third hatch, there were 5.5 per cent dead germs from the hens' lot, and 7.0 per cent in the pullets' lot. An aggregate of the three trials showed the very slight difference of 0.9 per cent; there was 7.0 per cent dead germs in the hens' lot, and 6.1 per cent in the pullets' lot.

Pipped. An examination of table 1 shows that in the first hatch, 2.5 per cent of the eggs from the hens' lot were pipped, but did not hatch; in the pullets' lot, there was only 1.0 per cent. In the second trial, there were 1.5 per cent pipped in the hens' lot and 0.5 per cent in the pullets' lot. In the third hatch, 3.0 per cent of the hens' eggs were pipped, and only 1.0 per cent in the pullets' lot. The average of the three trials gave a difference of 1.5 per cent in favor of the pullets' eggs. This result indicates that the embryos in the pullets' eggs were considerably more vigorous than those in the hens' eggs.

Cripples. Further examination of table 1 will show that there was not a very great difference in the percentage of crippled chicks that were hatched from both lots. In the first trial, there were 5.0 per cent cripples from the hens' lot and 4.5 per cent from the pullets' lot. In the third hatch, there was an even percentage of cripples in the two lots, being 1.0 per cent in each. A total of the three hatches shows that there were 2.3 per cent cripples from the hens' lot and 2.0 per cent from the pullets' lot, the difference being only 0.3 per cent.

Hatchability. Computing the hatchability on the basis of eggs set in each hatch, the pullets gave a higher percentage of hatch than the hens. As may be seen from table 1, the pullets had always a consistently higher percentage of hatchability than the hens in all the three trials. When the average for the three trials was considered, there was a difference of 11.3 per cent in favor of the pullets' lot.

This difference was so consistent that practical breeders of poultry would probably find it advantageous to select eggs for hatching purposes from younger birds instead of from older ones.

Weight of the chicks at hatch. Referring to table 1, again, it may be noted that in the first two trials the chicks which were hatched from the hens' eggs were slightly heavier than those which were hatched from the pullets' eggs. In the third hatch, however, there was no difference noted in the average weights of the chicks at hatch. In the aggregate of the three trials, a statistical study showed a very significant difference in the average weights of the chicks, in favor

of the hens' lot. The chicks from the hens' eggs weighed, on an average, 29.9 $\pm$ 0.0964 grams, while those from the pullets' lot weighed 29.2 $\pm$ 0.0837 grams, the difference of the means being 0.71 $\pm$ 0.1276 grams.

Jull and Quinn (1925) and Upp (1928) stated that there is a definite relationship between the size of the egg and the size of the chick. Our results in this study corroborated this statement. The heavier average weight of the chicks which were hatched from the hens' eggs may be accounted for by the heavier average weight of the hens' eggs set.

Growth. As has been previously stated, in the first two hatches, the chicks from the hens' eggs averaged slightly heavier than the chicks which were hatched from the pullets' eggs; but in the last hatch, the difference was slightly in favor of the pullets. The growth records of these chicks are given in table 2 by reference to which it may be seen that there is a clear indication that there was practically no difference in the growth of the two lots.

It may be seen from table 2 that for the first trial, during the early brooding period, the average weight of the chicks from the pullets' eggs gradually became greater than that of the chicks hatched from the hens' eggs. From the time they were hatched, the rate of increase of the birds in both lots gradually increased, and as the birds grew older, there seemed to be a proportionate increase in the weight at the last weighing. After the twelfth week, a faster rate of increase was noticed. The birds were culled at the end of the twelfth week, which may have accounted for the more rapid increase in their weights. The growth of the chicks in the second hatch, as may be seen in table 2, is quite similar to the growth curve for the first trial, except that there was a closer coincidence of the growth curve for the hens' lot and that for the pullets' lot in the second trial. With the chicks that were hatched in the third trial the behavior was essentially the same as in the first two trials.

Culls at three months. An examination of the weight records of the individual birds showed that at the age of three months the chickens that were raised from the hens' lot were a little more uniform than those raised from the pullets' lot. This finding may be accounted for by the greater range in the weight of the pullets' eggs, than in that of the hens' eggs, as previously noted.

It may be seen from table 3 that there was a very slight difference in the percentage of culls at the age of three months in the first two hatches. In the third hatch, however, there was 53.8 per cent culls in the pullets' lot, and only 39.1 per cent in the hens' lot.

This may have accounted for the greater percentage of birds laying at the age of six months in the pullets' lot of the third hatch, as may be seen in table 4. An average of the three trials showed that there were 39.6 per cent culls for the hens' lot, and 43.5 per cent for the pullets' lot, with an insignificant difference of only 3.9 per cent.

Maturity. As shown in table 4, the bird that laid the first egg in the lot for each trial was always from the pullets' lot. For the three trials, an average of the age of the pullets that laid the first eggs in the lots showed no appreciable difference. For the hens' lot, the average age was 134 days, for the pullets' lot, 130 days, the difference being only 4.0 days.

It may also be seen from table 4 that in the first two trials made, there was a higher percentage of birds laying at the age of six months in the hens' lot, while in the last hatch, there was a considerably higher percentage of birds laying in the pullets' lot at this age. The average for the three trials showed that in the hens' lot, 12.1 per cent of the birds laid at the age of six months, in the pullets' lot, 12.4 per cent, giving a difference of only 0.3 per cent.

The average weights of the first ten eggs produced by the birds that laid before the age of six months may also be seen in table 4. The average weight of the eggs laid from the hens' lot was 29.9 grams, for the pullets' lot, 29.0 grams, the difference being 0.9 grams.

In the three hatches made, comparing the weights of the birds at the age of six months, it was found that the two lots were almost the same as to the uniformity of the individuals.

Mortality. In all cases, mortality was heaviest during the first four weeks of brooding, as may be seen from table 5. This may be because this is the period in which the chicks are the most susceptible to colds and other diseases. It may also be noted from the same table that as the birds grew older, the percentage of mortality decreased. The weak and sick birds having died, or been culled at the age of three months, such a result might be expected. A further examination of table 5 showed that there was no consistent difference in the average mortality of the two lots in the three trials made, which tends to show that there was no appreciable difference in the vitality of the individuals hatched from both lots.

SUMMARY

1. Although selected hens' eggs were only slightly heavier than selected pullets' eggs, this difference between the hens' and pullets' eggs was decidedly significant.

2. In the Los Baños Cantonese chicken, the fertility and hatchability of the pullets' eggs were found to be higher than those of the hens' eggs.

3. There was a greater tendency for the occurrence of more pipped eggs from the hens' eggs than from the pullets'.

4. A significant difference was observed between the weights of the chicks hatched from the hens' eggs and those hatched from the pullets' eggs.

5. In both lots, chick mortality was heaviest during the first four weeks of the brooding period.

6. There was no appreciable difference noted in the growth of the birds in the two lots.

7. The difference between the average weights of the first ten eggs of the birds in the two lots that were laid before the sixth month was very slight.

8. No discernible difference was noted in the vigor and vitality of the birds raised from the hens' eggs and those raised from the pullets' eggs.

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TABLE 1

Incubation results

ITEMS	HATCH 1		HATCH 2		HATCH 3		SUMMARY	
	Hens	Pullets	Hens	Pullets	Hens	Pullets	Hens	Pullets
Number of eggs set	200.0	200.0	200.0	200.0	200.0	200.0	600	600
Av. wt. of eggs in grams	44.1	41.8	43.0	41.9	42.5	42.9	43.4 ± 0.1068	42.1 ± 0.0975
Percentage infertiles	13.0	9.5	19.5	14.0	32.0	19.0	21.5	14.1
Percentage D_1 [a]	9.5	4.0	4.5	5.5	13.5	16.0	9.1	8.5
Percentage D_2 [b]	3.0	2.0	7.0	2.5	8.0	10.5	6.0	5.0
Percentage D_3 [c]	7.5	5.5	8.0	6.0	5.5	7.0	7.0	6.1
Percentage pipped	2.5	1.0	1.5	0.5	3.0	1.0	2.3	0.8
Percentage crippled	5.0	4.5	1.0	0.5	1.0	1.0	2.3	2.0
Percentage hatched	64.5	78.0	59.5	71.5	38.0	46.5	54.0	65.3
Av. wt. of chicks at hatch, in grams	29.8	28.9	29.8	28.8	30.2	30.2	29.9 ± 0.0964	29.2 ± 0.0837

[a] D_1—Dead germs, first week.
[b] D_2—Dead germs, second week.
[c] D_3—Dead germs, third week.

TABLE 2

Growth record

AGE	HATCH 1				HATCH 2				HATCH 3				TOTAL			
	Hens		Pullets		Hens		Pullets		Hens		Pullets		Hens		Pullets	
	Individuals	Av. wt.	Individuals	Av. wt.	Individuals	Av. wt.	Individuals	Av. wt.	Individuals	Av. wt.	Individuals	Av. wt.	Individuals	Av. wt.	Individuals	Av. wt.
weeks	*number*	*grams*	*number*	*grams*	*number*	*grams*	*number*	*grams*	*number*	*grams*	*number*	*grams*	*number*	*grams*	*number*	*grams*
At hatch	129	29.7	156	28.9	119	29.8	143	28.8	77	30.2	93	30.2	325	29.9	392	29.2
1	111	31.0	136	31.8	114	35.1	136	32.8	68	35.7	83	36.3	293	33.9	355	33.6
2	89	35.1	118	37.9	97	45.7	120	41.7	64	46.1	78	47.5	250	42.3	316	42.3
3	82	44.8	106	53.0	94	57.9	115	53.6	59	58.8	70	60.1	235	53.8	291	55.5
4	81	59.3	101	69.5	87	72.3	110	68.2	50	74.3	59	75.2	218	68.6	270	70.9
5	78	70.8	100	89.0	79	89.1	103	86.2	49	90.4	57	90.7	206	83.4	260	88.6
6	77	93.4	100	112.7	75	110.3	100	107.5	49	111.5	56	109.7	201	105.0	256	109.9
7	77	127.9	100	137.5	73	134.3	99	133.9	48	134.9	54	133.5	198	132.3	253	134.9
8	76	151.8	100	164.2	73	159.4	99	160.6	47	165.4	53	161.5	196	158.8	252	162.1
9	76	184.5	100	191.8	72	186.9	99	192.4	46	193.6	53	188.4	194	188.3	252	190.8
10	76	215.3	100	221.0	70	216.0	97	220.4	46	221.7	52	217.1	192	217.6	249	219.5
11	76	250.6	100	254.9	70	249.2	95	253.0	46	243.9	52	243.0	192	244.5	247	250.3
12	76	294.4	100	286.8	69	283.2	95	287.0	46	278.6	52	273.2	191	285.4	247	282.3
14	31	423.3	39	407.0	32	388.2	44	378.9	19	377.6	16	362.5	82	396.3	99	382.8
16	31	548.3	39	530.7	32	502.3	43	490.0	19	490.7	16	475.0	82	513.7	98	498.5
18	31	698.3	39	663.4	32	643.3	43	611.3	19	611.8	16	568.5	82	648.1	98	614.4
20	31	850.0	39	795.5	31	789.5	43	761.0	19	739.4	15	745.0	81	792.9	97	767.1
22	31	914.5	39	941.6	31	912.9	42	895.8	19	873.6	15	878.3	81	900.3	96	905.2
24	31	1122.5	39	1133.9	31	1071.7	42	1087.5	19	1068.4	15	1111.6	81	1087.5	96	1111.0

TABLE 3

Culling record

ITEMS	HATCH 1		HATCH 2		HATCH 3		TOTAL	
	Hens	Pullets	Hens	Pullets	Hens	Pullets	Hens	Pullets
Number of birds at 3 months ...	76	100	69	95	46	52	191	247
Number of culls at 3 months ...	31	40	27	35	18	28	76	103
Percentage culls at 3 months ..	40.7	40.0	39.1	36.8	39.1	53.8	39.6	43.5

TABLE 4

Maturity record

ITEMS	HATCH 1		HATCH 2		HATCH 3		AVERAGE	
	Hens	Pullets	Hens	Pullets	Hens	Pullets	Hens	Pullets
Age in days of pullet that laid first egg in the lot	134	131	128	126	140	135	134	130
Percentage laying at 6 months .	12.9	10.2	12.9	7.1	10.5	20.0	12.1	12.4
Av. wt. in grams of first ten eggs laid prior to six months of age	28.0	26.7	29.5	29.2	32.2	31.1	29.9	29.0

TABLE 5

Mortality record

AGE	HATCH 1				HATCH 2				HATCH 3				TOTAL			
	Hens		Pullets		Hens		Pullets		Hens		Pullets		Hens		Pullets	
	Died	Died	Died	Died	Died	Died	Died	Died	Died	Died	Died	Died	Died	Died	Died	Died
weeks	*number*	*per cent*	*number*	*per cent*	*number*	*per cent*	*number*	*per cent*	*number*	*per cent*	*number*	*per cent*	*number*	*per cent*	*number*	*per cent*
4	48	37.2	55	35.2	32	26.8	33	23.0	27	35.0	32	34.4	107	33.0	120	30.8
8	4	5.1	1	1.0	14	17.7	11	10.6	3	6.1	6	10.5	21	9.6	18	7.3
12	0	0.0	0	0.0	4	5.5	4	4.0	1	2.1	1	1.8	5	2.5	5	1.9
16	0	0.0	0	0.0	0	0.0	1	1.0	0	0.0	0	0.0	0	0.0	1	0.3
20	0	0.0	0	0.0	1	3.1	0	0.0	0	0.0	1	6.2	1	1.0	1	2.0
24	0	0.0	0	0.0	0	0.0	1	2.3	0	0.0	0	0.0	0	0.0	1	0.7

A REVIEW: "POULTRY BREEDING"[1]

Over thirty generations of hens have passed since the rediscovery of Mendel's papers dealing with the laws of heredity, and it has been shown beyond doubt that the numerous characters which the domestic fowls possess are inherited in accordance with Mendelian principles. Many of these characters are of great economic importance. It is generally accepted that improvement in methods of rearing and feeding would do much toward increasing the returns from the average flock within the limits set by heredity but beyond which further improvement is impossible.

In the book under review, Doctor Jull who is senior poultry husbandman in the United States Bureau of Animal Industry has not only put together scattered facts about the breeding of poultry but has succeeded in explaining clearly the manner by which the various characters possessed by the domestic fowls are transmitted from parent to offspring in each succeeding generation. His explanations are founded upon elucidations by the numerous researches which have served as the bases for further and more rapid improvement of the different breeds. Doctor Jull also presents the most successful practices in breeding now used in the United States and elsewhere. These two discussions and other features should make the book of interest to Philippine poultry raisers, students and teachers in general but more particularly to the investigators in the field of poultry husbandry.

The subject matter is presented very succinctly in twelve well balanced chapters, the most important of which, from a practical view point, are the breeding practices and the poultry breeding improvement plans. Reading these chapters one gets a very definite idea of what constitutes a breed. He distinguishes between facts and notions regarding sex reversal, atavism, telegony, inheritance of acquired characters and prepotency, appreciates the importance of the problem of disease resistance, and gets a good perspective of the objectives sought in the different methods of breeding.

Of particular interest to the breeders of poultry in the Philippines is the statement that new breeds have been produced from a

[1] JULL, MORLEY A. Poultry breeding. 1932.
xiv + 376 p., 71 fig. Price, \$3.75 net. New York: John Wiley & Sons, Inc.
General contribution from the College of Agriculture No. 355.

very small number of ancestral forms by crossing existing breeds and then practicing rigid selection until the desired characters were transmitted with reasonable regularity and that breed improvement can be carried on largely from the standpoint of perpetuating desirable characters possessed by races and strains of poultry. These principles are, of course, not unknown to modern breeders of live stock. Neither is it unknown that all breeds of poultry have their merits and demerits in different places in different times. But the author has not limited himself to mere statement of facts—he tells how improvement has been accomplished and how further progress may be made.

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CURRENT NOTES

From time immemorial coir has been used for matting, brushes, ropes and cord. Its elasticity and resistance to decay make it an excellent material for these purposes, but the older methods of preparation have limited the uses, as the fibre so obtained was brittle, and dark in colour, with low tensile strength. The improved methods of preparation have resulted in the production of material of lighter colour which is soft enough to be spun and woven on jute machinery. This has opened up a new field of uses, particularly for sacks, carpets and rugs. As a protective material for underground pipes and cables the experimental stage has now been passed. The high resistance to decay by water or bacterial action, added to the fact that impregnation with tar or bitumen is easy, make coir very suitable for this purpose, and the increased pliability renders it possible to cover pipes of narrow bore with good contact all round.

Research into the uses of coir has received a strong fillip from the chemical methods of preparation, and rapid developments are probable.

Tropical Agriculture, (Trinidad, B. W. I.) April, 1933.

Goat's milk can be used wherever cow's milk can; it is in every way as suitable an article of diet as cow's milk. Moreover, goats never suffer from tuberculosis, they are cheaper to buy than cows are, and they can be kept under many conditions where it is impossible to keep cows.

Goat's milk needs to be kept just as carefully from contamination by harmful germs as cow's milk; these germs are generally carried by flies or dust. It therefore needs to be kept *clean, cool,* and *covered.* It should be brought to the boil directly it is received, poured straight into a freshly-scalded jug, cooled down quickly, and kept in the coolest possible place—preferably standing in water in a draught with a saucer resting on a piece of butter muslin covering it. The corners of the muslin should be dipping into the water, thus keeping the milk cool by evaporation. Milk treated in this manner should keep perfectly fresh for at least twelve hours, even in the hottest weather.

Queensland Agricultural Journal (Australia) May, 1933.

At the present time, Palestine has an area of roughly 120,000 donums or approximately 28,000 acres under citrus fruits, a considerable portion of which is not yet in full bearing. This season's export is estimated as being in the neighbourhood of 3,250,000 cases, more than twice that of South Africa, and it is anticipated that within a few years exports will have increased from 6,000,000 to 8,000,000 cases. It will thus be seen that in proportion to its size, Palestine produces more citrus fruits than any other country in the world.

The present season's prices are disastrously low...

The reasons for these low prices are in the main:

(a) heavy competition from Spain and the other Mediterranean countries;

(b) low standards of grading and packing, with the consequent exceptionally high percentage of wastage in transit.

The Tropical Agriculturist (Ceylon) April, 1933.

Larger local consumption of sugar to the extent of 45 pounds per capita, if possible, instead of only 21 pounds, is being urged by the trustees of the Philippine Sugar Association. The plan is to make the country consume annually no less than 250,000 tons of its actual sugar production. "The consumption of the Philippines in the last few years has been calculated to be 125,000 metric tons, which, among the approximate thirteen and half million people, would average a consumption of 21 pounds," said a statement of the trustees. "The consumption of New Zealand per capita is approximately 120 pounds, while the annual consumption in the United States is approximately 107 pounds per capita. It is thought that if the energy-given value

of sugar is appreciated in the Philippine diet, the consumption here could easily be increased to 40 or 50 pounds per capita, which would relieve the export of the Philippine crop by some 300,000 tons, or about one-third of the present production."

Commerce and Industry Journal (Philippines) April, 1933.

Cuban plantation concerns are beginning to recognise that cane grown on unsuitable land, cane transported for tonnage, not only yielded no profit when turned into sugar, but had the effect of reducing the value of the entire crop.

The Australian Sugar Journal, September 8, 1932.

It is known that where pigs are supplied liberally with skim milk, mineral substance, and nutritious grass or legumes, they will do less rooting than where they are underfed on palatable foods.

A pig roots to satisfy a desire for food nutrients. The desire may result from underfeeding, from poorly balanced rations, or from rations not as palatable as some substance a pig may find in the soil....

The Farmers' Gazette, (Ireland) October 15, 1932.

COLLEGE AND ALUMNI NOTES

Dean Gonzalez went on July 3 to Baguio where he plans to spend on accrued leave two and a half months. Mrs. Gonzalez and the children accompanied him. This is the first extended vacation the Dean has taken since his return from the United States in 1923. In addition to doing some real resting in the City of the Pines, Doctor Gonzalez is planning to do some writing which has been deferred because of lack of time.

The College faculty, students and employees wish for him days of relaxation in the mountain sunshine and nights of the peaceful rest that only the pine scented air of Baguio can bring. Baguio where budgets cease to trouble and the pedagogue can play.

Dr. N. B. Mendiola, head of the Department of Agronomy is Acting Dean during Doctor Gonzalez's absence.

Of interest to the College are the following items. They show forcibly the importance of Los Baños as a scientific center and the part the College of Agriculture has played in the development of scientists and scientific work in the Philippines.

In the fifth edition of *American Men of Science,* 1933, a biographical directory edited by J. McKeen Cattell and Jaques Cattell of New York, 69 names appear from the Philippines, 50 of which are Filipinos and 19, Americans. Of the 50 Filipinos, 23 are alumni of the College of Agriculture. Four of the Americans are at present or were in the faculty of the College of Agriculture, and three of the other Filipinos listed are or have been members of the faculty of the College also.

The following alumni of the College appear in the list: Dr. Felipe T. Adriano '19, Dr. Vicente C. Aldaba '15, Dr. Dionisio I. Aquino '21, Dr. Jose M. Capinpin '20, Dr. Pedro A. David '19, Dr. Rafael B. Espino '15, Dr. Bienvenido M. Gonzalez '13, Dr. Leon G. Gonzalez '22, Dr. Alexander Gordon '23, Dr. Jose B. Juliano '23, Dr. Nemesio B. Mendiola '14, Dr. Jose J. Mirasol '15, Dr. Gerardo O. Ocfemia '15, Dr. Elias H. Pañganiban '16, Dr. Eduardo Quisumbing '18, Dr. Francisco O. Santos '19, Dr. Anastacio L. Teodoro '18, Dr. Nicanor G. Teodoro '15, Dr. Juan P. Torres '19, Dr. Leopoldo B. Uichanco '15, Dr. Toribio Vibar '12, Dr. Deogracias V. Villadolid '19 and Dr. Valente E. Villegas '13.

The four Americans listed that are or were on the faculty of the college are: Professor Reginald H. King, Dr. Robert L. Pendleton, Dr. Edwin B. Copeland and Dr. William H. Brown. A number of former professors of Los Baños listed in the directory are no longer Philippine residents.

The other three Filipinos who are or have been members of the College faculty are: Dr. Miguel Manresa, Dr. Vicente G. Lava and Dr. Angel S. Arguelles.

At the convention of the Philippine Scientific Society on February 14 to 18, of the 115 scientific papers read, 44 were from members of the College of Agriculture faculty and alumni.

These figures point out the importance of Los Baños as a scientific center and the part played by the College of Agriculture in the development of scientists and scientific work in the Philippines.

The eighty-third regular scientific meeting of the Los Baños Biological Club was held in the Lecture Hall of the Poultry Building, College of Agriculture on Thursday, June 22, 1933, at 7:30 p. m.

The following papers were read and discussed:

"Destructive distillation of some agricultural waste products."

By Dr. A. I. de Leon and Mr. R. Reyes.
Paper read by Mr. Reyes

"Truck field tests in Calamba Sugar Estate using denatured alcohol, dehydrated alcohol and gasoline as fuels."

By Dr. A. L. Teodoro and Mr. Jesus P. Mamisao.
Paper read by Doctor Teodoro

"The Los Baños Biological Club: Ten years of continuous active interest."
By Dr. Miguel Manresa

Reprinted in *Tropical Agriculture,* (Trinidad B. W. I.), June 1933 from *Horticultural Abstracts,* Vol. III, No. 1, is an abstract of the article, by Claro C. Bagalso on "Top working old coffee trees which are poor yielders" which was published in *The Philippine Agriculturist,* December, 1932.

Dr. Vicente Dawis with the assistance of his class in Agronomy 21 (Floriculture and Landscape Gardening), is making an effort to induce residents on and near the College Campus, especially those living by the road from Barrio San Antonio to the Campus, to beautify their yards by planting ornamental or flowering plants. Some noticeable results have already been obtained.

Mr. Juan Villanueva, as a special student, is pursuing an intensive course in making soap from coconuts this semester. His course is mainly lectures on use of oils in Agronomy 16, and laboratory work in soap making. Mr. Villanueva is from Bolinao, Pangasinan. In this province soap making is largely in the hands of the Chinese. Mr. Villanueva hopes as a soap manufacturer to break into this monopoly.

Among the experiments on cover crops carried last year by the Department of Agronomy was one on *Coronilla varia* on the suggestion of the United States Department of Agriculture. A planter in Negros had written to the department for seed of *Coronilla varia.* For fear that this plant might turn out to be a pernicious weed in this country the department sent the seed to this College with soil inoculating material for study. The study, run for 14 months, shows that there need be no fear of *Coronilla varia* as a pernicious weed, also that as a cover crop its qualities are inferior to many now in use in the Philippines.

Mr. Simplicio Tiglao, B. Agr. '28 of Mabalacat, Pampanga accompanied by two brothers were recent Campus visitors. The principal object of their visit was to make inquiries in the Department of Agronomy about cassava culture and starch manufacture. They obtained planting materials of the four best varieties.

Other visitors seeking information about cassava starch manufacture were Mr. Gregorio Katigbak from Lipa, Batangas and his brother, a former student in the College.

The Department of Agronomy has in storage a quantity of cassava starch of high quality which is for sale.

Mr. Roberto Tirol, B. S. Agr. '32 was a recent Campus visitor. His special objects were seeking counsel on some agricultural matters and obtaining seed of mungo, cowpea and avocado. Mr. Tirol is in charge of a 100-hectare coconut plantation on the home hacienda in Ibajay, Capiz. He has just started a cattle ranch on Carabao Island with a herd of 40 selected native cows and a Nellore bull.

The Secretary of the College reports that the total registration in the College of Agriculture for the first semester of the college year 1933-1934 is as follows:

College of Agriculture	510	students
Cross registrations from:		
(a) U. P. Rural High School	27	"
(b) School of Forestry	18	"
Total registration	555	students

GRASSES AND MAN

Human life has been and is more dependent upon grasses than upon any other group of living things.

Geologic grassland and primitive man

The Miocene epoch is characterized by the formation of extensive grassland areas which replaced the swampy vegetation of the preceding epochs. It also presents a world-wide prevalence of the ancestors of most grass-eating (herbivorous) mammals. These animals, by contrast with their weak-toothed and short-limbed ancestors, possessed long-crowned and strong teeth adapted for grinding grass and relatively long feet adapted for running over hard and dry grassland in search of water and to escape from enemies. The abundance of grass favoured the multiplication of the herbivorous mammals. This in turn furnished an increased food supply for flesh-eating (carnivorous) animals, and, as a consequence, these also increased in number. The grasses were thus the controlling influence in the Age of Mammals.

The human importance of this fact is that primitive man was obliged to follow these animals--his almost exclusive food supply—as they wandered from grassland to grassland. Even after he domesticated certain of the mammals—the horse, ox, sheep, goat, pig and dog—he continued to be a nomad because he still had to herd these animals from one favourable grassland to another. Virtually all primitive men were characterized by this wandering life until certain of them, in various parts of the earth, observed that several of the grasses which their animals ate produced seeds which were not only edible food but were capable of remaining so for a considerable time. Man, in other words, discovered that he could store good food for himself. Thus man ceased to be dependent entirely for his food upon his animals, which in turn fed upon the pasture grasses. The cereal grasses became a direct portion of man's diet and furnished him with some nourishment which he could obtain by staying in one place.

By thus becoming a grass-eater, man changed his life from that of a nomad to that of a settler. This change was tremendously important for mankind of all times. There have not been any beginnings of civilization apart from agriculture. The earliest known

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agriculture was the cultivation of the cereal grasses, which resulted in the conservation of the human energy formerly wasted in roaming, in a sense of ownership, in the development of tools and appliances from various metals, in periods of leisure time during which thought, language, literature and art could make their first appearance in human life, in the beginning of settled and social life, and, in fact in the introduction of most aspects of civilization.

Every known primitive civilization was built directly upon one or another of the cereal grasses, sometimes supplemented with pasture grasses.

Civilization in Asia

In Japan, millet and rice were cultivated since primitive times.

Human life in China, in the Indian Archipelago, in the Malay Peninsula and in the Philippine Islands was dominated by rice.

The primary food of the Aryans in northern India consisted of rice. Barley and sugar cane were also used extensively. The Aryans had pasturelands on which they grazed their animals which furnished meat and the means of transportation. Guests and gods were honoured by being seated on grass mats. To their gods they offered up roasted grain (probably barley) and cooked rice.

The Proto-Nordics were an entirely pastoral people. They were nomadic and followed grasslands in Central and Western Asia. The invasions of the Huns, Tartars and Mongols were motivated by the necessity of finding new grasslands for their animals.

In Persia wheat was the chief constituent of human diet.

In Babylonia, about 3100 B. C. land was paid for by bronze and by grain. About 1400 B. C., there was an appliance for ploughing the land and sowing the seed of grain in the same operation. In 450 B. C. the Historian Herodotus wrote: "the soil is peculiarly adapted to grain; no fruit trees are grown; only barley, wheat and millet are grown."

In the palace of the King of Iberia stood gold and silver vessels filled with barley juice.

The Hebrew patriarchs were shepherds of animals on grasslands. Joseph in his first dream, saw "sheaves of grain." Moses promised the Hebrews that "He (God) will put grass in your fields for your cattle." Nearly all of the religious sacrifices included a grass eating animal or grain of the cereal grasses. The story of Ruth is built around barley and wheat. There are numerous other references to grasses in the Bible.

Civilization in Africa

In Egypt, wheat and barley were cultivated by 400 B. C. In the Egyptian "Book of the Dead," King Osiris states: "I am Osiris. I live as Grain. I grow as Grain. I am Barley." The Pharaoh of Joseph's time, in his first dream, saw seven fat cows grazing in the meadow grass, and his second dream pertained to "seven ripe and seven thin ears of grain" (probably barley).

In other parts of Africa, civilization was based on another group of grasses, the sorghums. Barley and millet were also important articles of food.

Civilization in Europe

In what is now Switzerland and northern Italy, the chief crops cultivated by the Lake-dwellers were barley, wheat and millet. Wheat was cultivated in Hungary during the Stone Age. The Macedonians when invading Asia became familiar with the cereal grasses grown there and introduced them into their own country as food-crops.

In Rome the first known reaper was invented in connection with the harvest of grain. Polenta, a porridge made from barley, was fed to gladiators who were called *hordeari* from *hordeum,* the Latin name for barley. The word "cereal" is from the Latin *cerealia* which were grain festivals in honour of the goddess Ceres.

The Lithuanians, Germans, Celts, Gauls, Illyrians, Thracians (in modern Hungary) and Numantians (in modern Spain) ate millet, barley and wheat, and drank beverages made from these grains.

Civilization in America

The physical, social and religious life of the Mayas, Aztecs, Incas, Guatemalans, Peruvians and other American peoples was based on maize or Indian corn.

The early settlers in America brought with them from Europe seed of rye, wheat, oats and barley, and planted these for crops as early as 1625.

Other aspects of civilization

The calendar came into existence as a matter of necessity connected with cereal agriculture. Nomadic life required no calendar; the natural division of time into day and night was sufficient. But the cultivation of the cereals, to be successful, required a calendar according to which planting and other agricultural operations could be performed at the time found by previous experience to be best. In the earliest Babylonian calendar, the names of eight of the twelve months of the year refer to grain. In the Egyptian calendar, certain of the names of the months also refer to cereals, "Sprouting of the

Grain," "Making and Watering Barley," "Ripe Grain," and "Lady of the Granary."

The earliest problems in various branches of arithmetic concerned grasses—their agriculture, their conversion into flour and loaves of bread, and their distribution to the labourers. Some of the beginnings of geometry were likewise related to grasses—the measurement of the areas of grain fields and the consideration of various forms—cylinder, rectangle, or parallelopiped—as the most economical shape for granaries. What was probably the very beginning of astronomy was the institution of observing the moon as a basis for performing the steps in the cultivation of the cereal grasses at certain times. (Many people, even in civilized countries in this century, plant seeds of crops according to the moon.)

There were a few plants other than grasses which were cultivated before historic times, e.g., the soybean, datepalm, hemp, flax, peach, apricot and grapevine. In no case, however, was any civilization dependent upon any of these plants, whereas every known civilization has been made possible and necessary by the cultivation of one or another of the cereal grasses.

Characteristics of the grasses

The grasses are apparently ideal pasture-plants because, instead of growing as other plants do, at the tips of the leaves which are eaten off by the grazing animal, grasses grow at the joints, the lowermost of which are generally inaccessible to the animal's mouth and are therefore uninterrupted in their growth. This explains, too, the ability of lawn grasses to continue providing a turf in spite of frequent cutting.

As food for man, a cereal grass produces each year a large yield of edible, storable and transportable food, containing a great deal of nutriment for its volume. The grasses, in addition, grow in a greater variety of conditions of climate and of soil than do any other large plants. Grasses are the chief plants which possess all the characteristics in the right proportion for constituting man's basic food.

Uses of grasses

Bread is still the "staff of life." Breadstuffs, furnishing the sole or chief food of most of mankind, are made from grasses.

As for meat, it is true almost literally that "all flesh is grass." Animals feeding on grasses furnish beef, mutton, pork and poultry, and such by-products as milk, cream, butter, cheese, oil, eggs, wool and leather.

Most of the world's supply of sugar is made from the grass, sugar-cane. Molasses is made from sugar-cane and sorghum. Beers and similar beverages are made by fermenting the seeds of grasses —maize, barley, rice, bamboo, millet and others.

Grasses, in the form generally consumed by man, are deficient in both minerals and vitamins and must be supplemented, if growth and health are desired, by fruits and vegetables.

Building material and land reclamation

Where the bamboos grow, they constitute the material out of which houses, furniture and scores of other construction objects are built. Grasses are used in the tropics to build huts and tree-houses.

For the reclamation of useless or troublesome types of land, grasses are the leading plants. Beach grass is the pioneer for reclaiming sanddunes in the temperate regions of the world. Cord ("Rice") grass (*Spartine* spp.) is the prime plant used to reclaim mud-flats and tidal estuaries. Both of these plants are used notably in North America and in Europe. For reclaiming alkali lands for agricultural utilization, several grasses are the best adapted plants known.

Grasses in the landscape

Grass lawns render houses and other buildings attractive. Parks owe much of their beauty and probably all of their utility to grass. Golf courses and athletic fields are grass turfs. Some grasses are used as ornamental plants in gardens, e.g., bamboo, pampas grass, zebra grass, quaking grass and "gardener's garters."

Miscellaneous uses

A small portion of the world's supply of paper comes from grasses. "Straw" hats are made from the stalks of various grasses. Whisk-brooms and sweeping-brooms are manufactured exclusively from a grass known as broom corn. The standard feed for birds is the seed of canary grass. Fishing-rods, and the vaulting poles used in Olympic games, are the stems of bamboo.

Corn stalks yield furfural, which is used as a solvent in resins and lacquers, and as a preservative in veterinary embalming material. Corn-starch is used in the stiffening and finishing of textiles, as a finisher and filler in the manufacture of writing-paper, as a stiffener in laundry work, and as a constituent of baking-powder, pies, puddings, soap, paints, adhesive substances and asbestos products.

The bamboos furnish cooking and other domestic utensils, musical instruments, hats, smoking-pipes, clothing and literally hundreds of other every-day needs of millions of people living in the tropics.

The grasses cause more hay fever than probably any other group of plants. Although constituting one of the largest families of plants, the grasses contain hardly any poisonous representatives, only the stunted or second growth of the sorghums being poisonous to animals.

Extent of grasslands

Grassland is the prime form of vegetation on the great plains and prairies of North America, on the savannahs and pampas of South America, on the veldt covering immense areas of Africa, on the enormous steppes of Russia, Siberia, China and Manchuria, on the grasslands of Australia and New Zealand, and on the lesser grassland areas distributed elsewhere on the earth's surface.

Much land is covered with cultivated grasses. For example, Indian corn is grown in the United States on over 100,000,000 acres, a greater area than that of California. Similarly, rice, wheat, barley, millet, oats, sorghum, sugar-cane, bamboos and pasture grasses cover very large areas of the earth's surface. In all probability, grasses occupy a greater portion of the dry surface of the earth than all artificial and other natural formations combined.

Grasses grow in the Arctic regions, where they constitute approximately one fourth of all the flowering plants and are now numerous than any other single family of large plants. Grasses grow, by contrast, in the hottest portions of the tropics. They are found at sea-level and on the highest mountains, in the open and in shade, on plains and on hillsides, in water and in sand, in forests and in deserts, on alkali soils and on acidic soils. In fact, grasses are found, often to a dominant extent, in any environmental condition in which plants can grow.

The family of grasses contains a larger number of individuals than all other families of large plants combined.

Value of grasses

The most valuable crops in the world are grasses—the cereals, sugar-cane, bamboo and hay. Statistics do not include the grass on ranges and pastures which is consumed directly by animals without going into commerce, where its value can be recorded. In the United States, maize, hay, wheat, barley, oats, and rye have an annual worth of about six billion dollars. MORRIS HALPERIN, *University of California.*

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OBSERVATIONS ON THE DECOMPOSITION OF CELLULOSE IN CERTAIN PHILIPPINE FOREST SOILS [1]

D. I. AQUINO AND D. P. TABIJE

WITH ONE TEXT FIGURE

Cellulose is one of the organic constituents of plants and under favorable conditions, the more plant residues, green manure and stable manure added to the soil, the more cellulose will be decomposed.

The transformation of carbonaceous and nitrogenous substances has been attributed mainly to the activities of microörganisms in the soil, while the dissolution of minerals primarily depends on the saturation of the soil solution with carbonic acid and other organic acids, which are the products of the action of organisms on organic matter of the soil.

Various groups of organisms, including fungi, bacteria and actinomyces readily attack proteins to get their food. These organisms utilize the cellulose as a source of energy and transform a certain amount of the carbon contained in it into microbial protoplasm. For the synthesis of the cell substance, definite amounts of nitrogen are required. In other words, within certain limits, there is a definite ratio between the amount of cellulose that will be decomposed in a given soil and the nitrogen that is made available to the microörganisms decomposing cellulose, the ratio varying somewhat with the organisms active in the decomposition of the cellulose and with the environmental conditions. The intensity of this decomposing power can be determined either by the evolution of carbon dioxide or by the actual extraction of residual cellulose. The more fertile a soil is, the faster will be the decomposition of the soil organic matter, liberation of nitrogen, and decomposition of the cellulose (added to the soil, in the form of filter paper or straw). Thus the amount of cellulose decomposed in a given soil at a given time may serve as an index of the total amount of nitrogen that would become avail-

[1] Part of the data in this paper was taken from the thesis presented by the junior author for graduation in 1932 with the degree of Bachelor of Science in Agriculture, from the College of Agriculture No. 358; Experiment station contribution No. 904. Received for publication May 22, 1933.

able in such a soil in that particular period of time. The quantities of cellulose decomposed may differ with different soils, but in this case the relationship between the cellulose decomposition, carbon dioxide evolution, and nitrogen assimilation is practically the same.

REVIEW OF LITERATURE

According to Waksman and Heukelekian (1924), Christensen was the first to suggest that the power of soils to decompose cellulose may serve as an index of soil fertility. This was in 1910. Christensen showed that neither the physical condition of the soil, nor its reaction influence greatly its cellulose decomposing capacity. He also claimed that the presence of available nitrogen and the microbial flora exerts an influence in cellulose decomposition. In other words, this phenomenon of cellulose decomposition is stimulated by chemical and microbiological soil conditions.

Bear (1929) stated that while the organic matter content of the soil is an important factor in determining its productivity, yet it is not only the accumulation of organic matter in soil that is essential, but the constant passing through the soil of rapidly decomposing organic matter.

According to Waksman (1917) after organic matter is added to the soil, various groups or microörganisms act on it, a part of the organic matter is completely decomposed, with the formation of carbon dioxide, water, ammonia, hydrogen sulfide, etc.; another part is reassimilated by the microörganisms and synthesized into protoplasm; another is left undecomposed, being more resistant to the action of other native soil flora; and another part is left in the form of intermediate products. These are due either to their greater resistance to the microbial actions in general and to certain specific groups in particular, or to the fact that products are formed hindering the further development of the organisms.

Waksman and Heukelekian (1924) showed that "cellulose is decomposed in the soil by fungi, actinomyces and bacteria, including aerobic and anaerobic forms, thermophilic and denitrifying organisms. Probably all soils contain some, if not all, of these groups capable of decomposing cellulose." When cellulose is added to the soil, one of these groups may be favored more than the other, depending upon the presence of available nitrogen and phosphates in the soil.

The use of nitrogen by fungi is always associated with the use of an energy material. It has been pointed out by Coleman (1916), Waksman and Skinner (1926) that this nitrogen, if not an absolute

necessity in the decomposition of cellulosic material, is an aid in this process and hastens the utilization of the cellulose by the fungi. A definite relation between the cellulose decomposed and nitrogen assimilated by soil organisms, especially in the case of fungi, was found by Waksman and Heukelekian (1924). Waksman and Starkey (1923) and McBeth (1916) observed that the development of fungi in the presence of nitrogen was stimulated in a marked degree by the addition of pure cellulose to the soil.

The power of soil microbiological flora to decompose cellulose from the organic matter should not be underestimated. Numerous investigators have given due recognition to this fact. Evidently, the study of the organisms concerned in the decomposition of cellulose and some factors which tend to influence their activities has attracted the attention of many investigators. So far as the writers are aware, no work of this nature as yet has been undertaken for Philippine soils.

OBJECTS OF THE WORK

The present work was planned to study the rapidity of cellulose decomposition in certain Philippine forest soils as influenced by different conditions of management; and to determine the influence of certain chemical and physical properties on the amount of cellulose decomposed in soils.

SOIL STUDIES

A reconnaissance survey of the estate in question was made in April, 1931, and a more thorough soil survey was conducted from time to time until the close of the work.

The different lots were located first. Then their respective topography, soil texture, area and vegetation were noted. The elevation of the place is approximately 100 meters above Laguna de Bay. A detailed description of the lots and soils is shown in table 1.

As a whole, the topography of the land including the lots under investigation varies from rolling and sloping to steep slopes. The soil texture of the surface soil, however, is practically uniform in all of the lots, except lot V where the soil was mixed with brownish-yellow particles of apparently volcanic tuff materials. The present vegetation can not be used as a basis for describing the soil in the different lots because it is composed more or less of cultivated crops.

In the determination of the cellulose decomposition in the soil the method suggested by Waksman and Heukelekian (1924) was used.

The moisture content and the water-holding capacity of the soil were determined with the use of the methods outlined in *Soil Characteristics* by Emerson (1927).

The colloid content of the soil samples was determined with the use of the hydrometer method employed by Bouyoucos (1926).

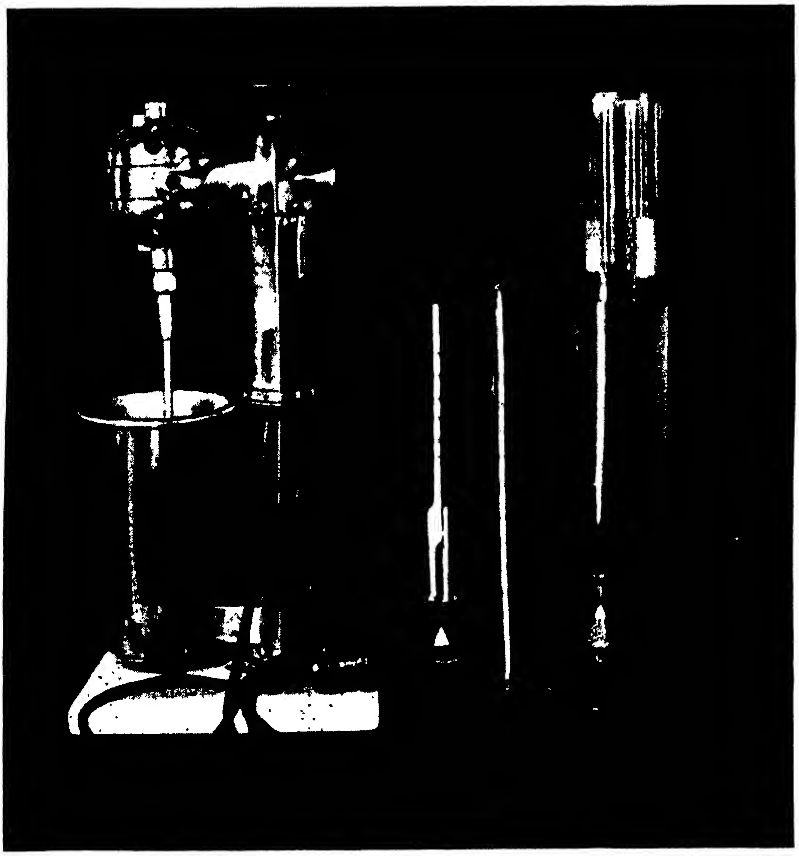

Fig. 1.—Apparatus used in the determination of the colloid content of the soil.

The quinhydrone pH indicator was used in the determination of the hydrogen ion concentration of the soil. The total nitrogen content of the soil was determined with the use of the Kjeldahl method (Hibbard-Gunning modification) as given in the *Official Methods of Analysis of the Association of Official Agricultural Chemists* (1926).

The data for rainfall and soil temperature were obtained from the weather stations of the Department of Plant Physiology, College of Agriculture, and the School of Forestry.

RESULTS

Table 1 shows the description of the soil of the Paliparan estate (a portion of Maquiling National Park).

There were 288 trials made for the cellulose determination.

Table 2 shows the averages obtained for the different determinations covering the entire period of investigation.

The averages of results obtained in the cellulose decomposition experiments are shown in columns 7, 8 and 9 of table 2 and in the last three columns of table 3. The cellulose decomposition is the amount of cellulose precipitated with 80 per cent alcohol from the treatments (as check, treated with filter paper alone, and treated with filter paper and 100 milligrams of sodium nitrate ($NaNO_3$).

The data presented in table 3 are averages of the different determinations of the entire period.

DISCUSSION OF RESULTS

As shown by the data presented in tables 1 and 3, the lots under consideration are under varied systems of forest management with varying topography and vegetation which seem to account for the variation noted in the results.

An examination of the results in table 3, shows that the soil samples did not change markedly in soil reaction. The colloid content and the soil temperature, although the latter decreased moderately during the progress of the work, did not show any appreciable bearing on the cellulose decomposing power of the soil. It may be noted that there was variation in the water-holding capacity, moisture content and total nitrogen content of the soils. This variation may be attributed to alternate heavy rains and sun exposure, especially during August, October and November, 1931, and to the steep topography with consequent soil erosion and disturbances in microbial activities, all of which may possibly have altered the conditions of the soil with special reference to the nitrogen content.

The effect of the amount of cellulose and nitrogen added under a constant period of incubation for each treatment upon the decomposition of cellulose in the soil is shown in columns 7, 8 and 9 of table 2, and in columns 8, 9 and 10 of table 3.

It is interesting to note that there was only a slight increase in the actual amount of cellulose decomposed with the addition of sodium nitrate and filter paper, and so with cellulose (filter paper) alone. This may be due to the disturbances that occurred in the soil with special reference to microbial flora caused by changing conditions mentioned above.

As shown in table 3, there seems to be an apparent correlation of the total nitrogen content and the soil reaction with the amount of cellulose decomposed in all the three treatments.

The effect of the different systems of forest management and the physical and chemical properties on the cellulose decomposing capacity of the soils found in these determinations are given in table 3.

Under the six systems of forest management considered; namely, cogonal, caiñgin, cultivated, cut-over area (2 months old), cut-over area (6 months old), cut-over area (5 years old), it seemed that the moisture content and the water-holding capacity were affected by topography and vegetation. Lots I, II, IV, V showed high moisture content, and lot I was apparently the highest in water-holding capacity.

An examination of the data in column 6 of table 3, shows that lots I and VI are slightly more acidic than any of the other lots. The acid condition of lot I may be due to cogon grass which, according to results of various investigations, is an acid producing plant. The acidity for lot VI may be attributed to the low moisture content.

The data in column 8 of table 3, show that lot I is the poorest in fertility as evidenced by the low percentage of cellulose decomposed, which may be accounted for by its acidic reaction, hindering the activity of some soil organisms.

The importance of leguminous plants like ipilipil (*Leucaena glauca* Linn.), etc, for a second growth forest in maintaining and increasing the fertility of the soil seems not to hold true in this study, as shown by the results obtained.

The averages of the results of cellulose decomposition and total nitrogen content from lots I, II and III are greater than those of lots IV, V and VI, showing that the former conserves fertility more than the latter. This may be due to the steep topography of lots IV, V and VI, which influenced sheet erosion of the soil, reducing thereby the organic matter content, and bacterial population that are responsible for cellulose decomposition. Fewer organisms mean less microbiological activity.

It is obvious that the results of these determinations are not enough to justify conclusive statements, but it is hoped that they may prove useful in pointing out the fact that there is a difference in effect of the various systems of forest management and the existing conditions on the fertility of the soil.

SUMMARY AND CONCLUSIONS

1. The results brought out in this study indicate the determination of the power of the soil to decompose cellulose, yielding information on the part played by microbiological flora and available nitrogen in the decomposition of cellulose.

2. A comparative study of the influence of some of the physical and chemical factors in the soil, and the effects of different systems of forest management upon the soil bacterial activity with special reference to its cellulose decomposition was made.

3. The colloidal content of the soil varied from 38.62 per cent in lot I to as high as 46.07 per cent in lot V with no apparent correlation with any of the soil characters investigated.

4. The soil reaction remained slightly acidic throughout, the cogonal area being the most acidic of all the lots.

5. The soil reaction and the nitrogen content appear to have some slight bearing on the cellulose decomposing power of the soil.

6. The percentage of cellulose decomposed decreased with the addition of cellulose particularly with the cut-over areas covered with ipilipil (*Leucaena glauca* Linn.).

7. The extent of cellulose decomposition in the soil with the addition of available nitrogen in the form of sodium nitrate is quite marked as compared with the cellulose addition and the check.

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TABLE 1

Giving the description of the soil of the Paliparan Estate (a portion of Maquiling National Park)

LOT NO.	CHARACTER OF THE LOT	AREA	TOPOGRAPHY	TEXTURE	VEGETATION
		sq. m.			
I	Cogonal	538	Rolling	Clay loam, residual surface soil	Cogon
II	Caiñgin	2,340	Rolling and sloping	Clay loam, residual surface soil	Rice
III	Cultivated	2,150	Rolling	Clay loam, residual surface soil	Rice and corn
IV	Cut-over area (2 months old)	1,115	Steep slope	Clay loam, residual surface soil	Ipilipil
V	Cut-over area (6 months old)	609	Steep slope	Clay loam, residual surface soil	Ipilipil
VI	Cut-over area (5 years old)	520	Steep slope	Clay loam, residual surface soil	Ipilipil

TABLE 2

Showing the sampling period, water-holding capacity, colloid content, moisture content, soil reaction, total nitrogen content, cellulose decomposing power, soil temperature, and rainfall[a]

SAMPLING PERIOD	WATER-HOLDING CAPACITY	COLLOID CONTENT	MOISTURE CONTENT	SOIL REACTION	TOTAL NITROGEN	CELLULOSE DECOMPOSING POWER			SOIL TEMPERATURE	RAINFALL
						Check, 42 days incubation	One gram filter paper added; 42 days incubation	One gram filter paper and 100 mgm. $NaNO_3$ added 15 days incubation		
						Residual cellulose	Cellulose decomposed	Cellulose decomposed		
	per cent	*per cent*	*per cent*	*pH*	*per cent*	*per cent*	*per cent*	*per cent*	*°C.*	*mm.*
April 1, to May 5, 1931	54.05	46.82	27.40	6.55	0.2144	0.117	0.070	0.172	37.65	126.00
May 6, to June 21, 1931	51.97	46.82	32.92	6.22	0.1974	0.045	0.070	0.138	33.92	137.21
June 22, to Aug. 2, 1931	57.44	44.14	36.60	6.09	0.1982	0.050	0.094	0.216	31.04	279.96
Aug. 3, to Sept. 13, 1931	56.04	43.52	45.22	6.11	0.1735	0.038	0.044	0.103	30.01	165.98
Sept. 14, to Oct. 25, 1931	56.35	41.74	48.60	6.40	0.1802	0.089	0.088	0.068	30.35	488.60
Oct. 26, to Nov. 22, 1931	54.79	35.09	47.17	6.47	0.1965	0.065	0.075	0.102	29.34	203.00
Nov. 23, to Dec. 13, 1931	51.85	32.67	49.79	6.21	0.2081	0.110	0.081	0.093	28.12	144.90
Dec. 14, to Jan. 10, 1932	57.65	32.44	43.23	6.38	0.1988	0.155	0.196	0.115	27.39	24.40

[a] The data given here are averages per sampling period.

TABLE 3

Showing the cellulose decomposing capacity of the soil as influenced by its physical and chemical properties, and different systems of forest management [a]

LOT NO.	CHARACTER OF THE LOT	PHYSICAL PROPERTIES			CHEMICAL PROPERTIES		CELLULOSE DECOMPOSING POWER		
							I	II	III
		Water-holding capacity	Colloid content	Moisture content	Soil reaction	Total nitrogen	Check, 42 days incubation	One gram filter paper added; 42 days incubation	One gram filter paper and 100 mgm. $NaNO_3$ added 15 days incubation
							Residual cellulose	Cellulose decomposed	Cellulose decomposed
		per cent	*per cent*	*per cent*	*pH*	*per cent*	*per cent*	*per cent*	*per cent*
I	Cogonal	60.18	36.67	46.01	6.20	0.1868	0.085	0.090	0.126
II	Caiñgin	53.01	40.23	42.41	6.37	0.2013	0.104	0.103	0.131
III	Cultivated	52.42	38.62	36.68	6.32	0.2025	0.102	0.107	0.131
IV	Cut-over area .... (2 months old)	56.15	41.77	45.31	6.35	0.1955	0.092	0.082	0.106
V	Cut-over area .... (6 months old)	52.68	46.07	42.07	6.35	0.1848	0.088	0.079	0.139
VI	Cut-over area .... (5 years old)	55.68	39.07	35.60	6.25	0.2048	0.093	0.080	0.113

[a] The data given here are averages of the different determinations of the entire period.

MECHANICAL INJURIES TO ROOTS AND CORMS OF ABACÁ IN RELATION TO HEART-ROT DISEASE [1]

MARIANO M. RAMOS

The importance of heart-rot as a disease of abacá (*Musa textilis* Née) has been reported by Ocfemia (1927, 1930, 1931) and Ocfemia and Mendiola (1932). These reports state that of the abacá heart-rot cases in bunchy-top districts 11 to 17 per cent are secondary symptoms. These investigators also noted that the combined effects of the infestation of abacá corms with weevils (*Cosmopolites sordidus* Germar) and infection with bunchy-top produce more than 80 per cent of heart-rot. They stated that the destruction of the feeding roots by various causes sometimes results in the production of the same trouble.

In the abacá heart-rot cases examined by the writer, practically all of the roots of the plants were rotted. Only the corms were left at the base of the pseudo-stem. In fact a heart-rotted abacá plant may be readily pulled out of the soil because the anchorage organs are dead and oftentimes completely rotted. Young roots may be produced but these sooner or later yellow and then rot. Observation of this condition suggested that, in addition to the physiological effect of bunchy-top on abacá, the destruction of the roots by parasites, such as fungi, bacteria and nematodes might cause heart-rot.

MATERIALS AND METHODS

The field observations were made on a total of 1000 abaca plants infected with bunchy-top. The occurrence of heart-rot as a final stage of bunchy-top was recorded. Heart-rot resulting from bunchy-top was identified by the browning of the youngest furled leaf. In case of doubt the presence of heart-rot was ascertained by cutting the suspected plants either crosswise or lengthwise. The presence of a blackened central cylinder was an indication of heart-rot. From these heart-rot cases, attempts were made to isolate the associated organisms. The infected materials were cut under aseptic conditions and

[1] Thesis presented for graduation, 1933, with the degree of Bachelor of Agriculture from the College of Agriculture, University of the Philippines No. 359; Experiment Station contribution No. 905. Prepared in the Department of Plant Pathology under the direction of Dr. G. O. Ocfemia.

plated out on sterilized corn meal in petri dishes. From the colonies of the organisms that developed, subcultures were made on potato-dextrose agar. The pathogenicity of these organisms was tried in controlled artificial infection experiments.

On the 1000 heart-rotted abacá plants, observations were made to determine the percentage which had root weevil, *Cosmopolites sordidus*, injury and the percentage with roots entirely rotted because of nematode, *Heterodera radicicola* (Greef) Müller infection. The occurrence of injuries caused by these two animal parasites was noted by digging up heart-rotted abacá plants and examining the roots and corms. It was first ascertained that the presence of tunnels in the corms was due to root weevils. Galls, varying from five millimeters to one centimeter or more in thickness, in the roots indicated infection by nematode. In doubtful cases the materials were examined under the microscope for the presence of nematodes.

In the determination of the production of heart-rot by cutting off portions of the roots of healthy abacá plants, seedlings of Puti-tumatagacan and Itom varieties obtained from Mr. Domingo Baybay of the Guinobatan Abacá Experiment Station of the Bureau of Plant Industry at Binogsacan, Guinobatan, Albay were used. The seeds were germinated and the seedlings transplanted in sterilized soil in 24-centimeter pots, following the method described by Ocfemia (1930). When the potted seedlings were about 30 centimeters tall they were divided into lots. In the first lot (1) about one-half of the entire root system was cut off with a sterilized sharp knife; in the second (2) about three-fourths of the roots were cut off; and in the third (3) about four-fifths. The roots were cut off as close to the corms as possible. To facilitate the cutting off of the roots the soil around the base of the plant was removed and after the roots were cut off it was put back.

Inoculations of young healthy abacá seedlings with the fungus isolated from heart-rot specimens were made, using pure cultures of the organism. At the time of inoculation the abacá seedlings were from two to five months old, counting from the date of transplanting. The fungus was applied on the injured and uninjured bases of the young and furled leaves. To make the injuries at the bases of the leaves they were punctured with the point of a needle. The control seedlings received the same treatment as the inoculated abacá except that they were treated with sterile water and sterile potato-dextrose agar instead of fungous cultures.

RESULTS AND DISCUSSIONS

The relation of bunchy-top, root weevil and nematodes to the production of heart-rot

The field surveys were made in the abacá fields of the Department of Agronomy of the College of Agriculture at Los Baños, Laguna and in Silang, Cavite. The data gathered in these surveys[2] are shown in tables 1 and 2.

It may be seen in table 1 that heart-rot cases following bunchy-top range from 10.49 to 22.1 per cent.

TABLE 1

Abacá heart-rot cases following bunchy-top in the abacá field in Silang, Cavite and in the College of Agriculture fields at Los Baños, Laguna

LOCATION OF ABACÁ FIELDS	DATE OF OBSERVATION	BUNCHY-TOPPED PLANTS EXAMINED	HEART-ROTTED PLANTS	HEART-ROT INFECTION
		number	*number*	*per cent*
Department of Agronomy .	July 21, 1930	105	16	14.28
Silang, Cavite	December 28, 1930	200	31	15.50
Department of Agronomy .	March 28, 1931	85	9	10.49
Silang, Cavite	October 13, 1931	110	20	18.10
Silang, Cavite	January 2, 1932	87	20	22.10
Silang, Cavite	April to May, 1932	413	72	17.40

The writer noted that some of the heart-rotted abacá plants were associated with advanced stages of bunchy-top. This result corroborates Ocfemia's (1927, 1930, 1931) finding that in bunchy-top infected districts, 11 to 17 per cent of the heart-rot cases are final stages of bunchy-top.

As shown in table 2, heart-rot cases following root weevil injuries range from 53.3 to 90 per cent and heart-rot resulting from nem-

TABLE 2

Abaca heart-rot cases following animal injuries to the roots and corms

DATE OF OBSERVATION	HEART-ROTTED PLANTS	PLANTS WITH ROOT WEEVILS	ROOT WEEVIL INFESTATION	PLANTS WITH NEMATODES	NEMATODE INFECTION
	number	*number*	*per cent*	*number*	*per cent*
July to Oct., '30	276	181	65.5	47	17.03
Nov. to Dec., '30	105	56	53.3	15	14.3
Jan. to Oct., '31	200	180	90.0	19	9.5
Nov. to Dec., '31	100	83	83.0	13	13.0
Jan. to May, '32	312	215	68.9	63	20.5

[2] The writer desires to express his thanks to the owners of the abacá fields in Silang, Cavite and to the workers employed for their kind assistance and coöperation when he was conducting his field work.

atode attack ranges from 9.5 to 20.5 per cent. It was noted that plants with their roots rotted because of nematode and weevil infestation had heart-rot.

The relation of the destruction of the roots and removal of the corms to heart-rot incidence

The effect of the removal of about one-half of the entire root system: Experiment 1. On February 20, 1931, the roots and portions of the corms were cut off of 13 healthy abacá plants of the Puti variety, seven months old. Four days later, the seedlings were placed outside of the laboratory under partial shade.

On May 10, 1931, or about four months later, symptoms of heart-rot were shown by 29 per cent of the plants of which portions of their root systems had been cut off.

Experiment 2. On September 25, 1931, 22 healthy abacá plants of Itom variety, six and one-half months old, were treated as in experiment 1. On February 13, 1932, seven abacá plants, or 31.8 per cent had symptoms of heart-rot.

The effect of removal of about three-fourths of the entire root system: Experiment 1. On February 22, 1931, three-fourths of the roots were cut off of 15 healthy abacá seedlings of Puti variety, seven months old. Six days later the seedlings were placed outside of the laboratory.

On May 11, 1931 or about four months later, five abacá seedlings, or 33 per cent of the plants, showed heart-rot.

Experiment 2. The experiment was repeated on September 23, 1931. Twenty-two abacá seedlings of variety Itom, which were about six and one-half months old were used. On February 10, 1932, or four months later, 8 seedlings or 36 per rent of the plants had heart-rot.

The effect of removal of about four-fifths of the entire root system of the abacá seedlings: Experiment 1. On February 26, 1931, about four-fifths of the roots were removed from 26 seedlings of abacá, variety Puti, which were seven months old. After four days the seedlings were placed outside the laboratory in a partially shaded place.

On May 17, 1931, or after about four months, 27.2 per cent of the seedlings showed heart-rot.

Experiment 2. On September 23, 1931 another experiment was conducted using 22 abacá seedlings of Itom variety which were six and one-half months old. On February 11, 1932, 45.4 per cent of the seedlings had heart-rot.

Experiment 3. A third experiment was conducted on May 25, 1932 using 10 seedlings of Puti-tumatagacan variety which were eight months old. On October 2, 1932, or after about five months, 3 of the abacá seedlings or 33.3 per cent had heart-rot.

The symptoms of the heart-rot developed in seedlings when portions of their roots were removed were similar to those of the heart-rot which followed bunchy-top. The disease was characterized by the rotting of the youngest furled leaf. The rotting began at the top and gradually advanced downward leaving the older leaves in a stunted condition.

When the diseased plants from all of the experiments were dug up, however, their corms were heavily infested with root weevil. The insects had bored holes through the corms and reached as far as the central cylinder. The injury caused by the insect on the corms of the plants seems to be the cause of the rotting of the heart.

The writer found that pruning off portions of the root systems of abacá seedlings weakened the plants and perhaps predisposed them to animal injuries which resulted in the production of heart rot.

Doctor Ocfemia is of the opinion that in addition to the destruction of the feeding roots, the production of heart-rot seems to be due to some physiological effect of a pathogen on the host plant. This physiological effect is perhaps toxic in nature. It prevents or retards considerably the growth of the apex. The rotting of the tissues immediately surrounding the apex prevents the youngest leaf from passing through them and causes it to rot also.

The relation of the fungus isolated from heart-rot cases to the development of the disease in artificial inoculation experiments

The occurrence of a species of *Fusarium* in some of the heart-rot specimens was noted by the writer. This was of interest because the heart-rot of abacá has been attributed by Lee and Serrano (1923), Teodoro (1925), and Teodoro and Serrano (1926) to a species of *Fusarium* similar to, if not identical with the banana wilt fungus, *Fusarium oxysporum* Schl. f. 3 Wr. (*Fusarium cubense* EFS). Ocfemia and Mendiola (1932) identified the fungus associated with certain cases of heart-rot with *Fusarium moniliforme* Sheldon var. *subglutinans* Wr. and Rg.

Artificial inoculation experiments were conducted in the laboratory to study the pathogenicity of the *Fusarium* from abacá heart. Morphological and cultural studies of the fungus were made and the results were compared with those of *Fusarium moniliforme* Sheldon var. *subglutinans* Wr. and Rg. of Ocfemia and Mendiola (1932).

Morphology: The fungus was studied to determine the color, septation, branching and contents of the mycelium; types, size and the contents of the spores; and the types, color and abundance of growth on the different media used.

Mycelium. In young cultures the mycelium is granular and the cells of the hyphae are short. With age the hyphae become less granular and vacuolate. They are straight, uniform in diameter and rarely constricted at the septa.

Conidiophores. The conidiophores are produced by the aërial hyphae or in the pionnotes. They are short lateral branches of the mycelium. On some culture media, especially oatmeal and potato dextrose agar and steamed rice, the conidiophores are well developed, much branched and constricted at the point of origin and at the septa, and sometimes bulge in the middle.

Conidia. In a 24 hour-old culture, conidia were present. They were numerous in older cultures. The conidia vary in size, shape and septation.

Microconidia. The microconidia are hyaline, oval or elongate and either 0- or 1-septate. Curved 0- or 1-septate microconidia were also produced. The 0-septate microconidia were from 6.6–21.6 $\times$ 2.4–4.7μ; average 14.1 $\times$ 3.4μ. The 1-septate microconidia were from 16.7–29.5 $\times$ 3.3–5.1 μ; average 22.6 $\times$ 3.7 μ.

Macroconidia. The macroconidia are hyaline, elongate or sickle-shaped and vary from 2- to 5-septate. The 2-septate macroconidia were from 22.5–33.5 $\times$ 3.3–4.7μ; average 27.0 $\times$ 4.1μ. The 3-septate macroconidia were from 26.6–41.3 $\times$ 3.8–5.1μ; average 31.8 $\times$ 4.6μ. The 4- and 5-septate macroconidia were very rare and were found only on oatmeal agar and steamed rice. The 4-septate macroconidia measured from 35.8–43.4 $\times$ 3.6–4.0μ; average 40.1 $\times$ 3.9μ. The 5-septate macroconidia measured from 57.9–70.7 $\times$ 3.5–4.4μ; average 60.7 $\times$ 4.1μ.

The measurements of the spores on the different media are as follows:

Six-day old culture on corn meal:

0-septate, 6.5–19.5×1.8–4.1 μ; average 11.3×3.4 μ;
1-septate, 12.5–23.7×3.2–4.3 μ; average 18.6×3.5 μ;
2-septate, 21.8–29.6×3.1–4.6 μ; average 25.7×3.9 μ;
3-septate, 24.7–39.9×3.4–4.7 μ; average 32.5×4.2 μ.

Eight-day old culture on oatmeal agar:

0-septate, 7.1–35.6×1.8–4.3 μ; average 27.9×3.5 μ;
1-septate, 27.1–38.9×3.2–4.4 μ; average 31.5×3.9 μ;
2-septate, 27.1–41.2×3.6–4.2 μ; average 34.6×4.0 μ;
3-septate, 28.0–43.2×3.9–5.3 μ; average 36.9×3.9 μ;
4-septate, 43.9–54.3×4.0–4.1 μ; average 45.4×4.0 μ;
5-septate, 57.9–70.7×3.5–4.4 μ; average 60.7×4.2 μ.

Eleven-day old culture on steamed rice:

0-septate, 6.4–21.7×1.9–4.3 μ; average 12.5×3.3 μ;
1-septate, 12.8–31.8×3.4–4.5 μ; average 22.8×3.6 μ;
2-septate, 19.6–36.4×3.5–5.3 μ; average 28.5×3.9 μ;
3-septate, 23.1–39.9×3.3–4.5 μ; average 30.9×4.1 μ;
4-septate, 27.8–42.6×3.2–4.0 μ; average 34.8×3.5 μ.

Fifteen-day old culture on potato agar + 10 per cent dextrose:

0-septate, 6.4–16.1×1.9–2.5 μ; average 10.4×3.5 μ;
1-septate, 16.0–28.9×3.6–7.4 μ; average 21.8×3.9 μ;
2-septate, 21.4–33.2×3.4–4.7 μ; average 32.1×4.2 μ;
3-septate, 33.5–43.4×5.1–6.3 μ; average 36.6×5.3 μ.

Fifteen-day old culture on potato-dextrose agar:

0-septate, 4.6–23.7×2.5–4.3 μ;
average 11.9×3.3 μ;
1-septate, 17.9–28.6×3.6–4.1 μ;
average 21.8×3.7 μ;
2-septate, 22.1–28.9×2.6–3.9 μ;
average 26.1×3.9 μ;
3-septate, 24.9–39.3×3.7–4.5 μ;
average 31.0×4.1 μ.

Seventeen-day old culture on potato agar;

0-septate, 8.9–14.3×2.9–5.9 μ;
average 11.4×3.9 μ;
1-septate, 14.1–25.3×3.2–6.1 μ;
average 18.6×3.7 μ;
2-septate, 23.2–30.3×3.8–5.5 μ;
average 27.1×4.8 μ;
3-septate, 25.7–42.3×3.5–5.4 μ;
average 34.7×4.2 μ.

Average measurement of spores:

0-septate, 6.6–21.8×2.4–4.7 μ;
average 14.1×3.4 μ;
1-septate, 16.7–29.5×3.3–5.1 μ;
average 22.6×3.7 μ;
2-septate, 22.5–33.5×3.3–4.7 μ;
average 27.0×4.1 μ;
3-septate, 26.6–41.3×3.8–5.1 μ;
average 31.8×4.3 μ;
4-septate, 35.8–43.4×3.6–4.0 μ;
average 40.1×3.9 μ;
5-septate, 57.9–70.7×3.5–4.4 μ;
average 60.7×4.1 μ.

It was found that the differences between the averages presented above and those of Wollenweber (1931) and Ocfemia and Mendiola (1932) for *Fusarium moniliforme* Sheldon var. *subglutinans* Wollenweber and Reinking (p. 397) are not significant to an extent to justify its segregation from this variety. (*See* table 3.)

The conidia germinate by the production of germ tubes, one at each segment. The cells of the conidium swell and become constricted at the septa at germination. The conidia do not produce chlamydospores. Ocfemia and Mendiola (1932) found, in a three-month old culture on oatmeal, chlamydospore-like structures in the

hyphae. These structures occurred either singly, in pairs or in chains. These authors, however, believe that the swollen short cells are not chlamydospores but only swellings of the hyphae.

TABLE 3

Showing the comparative length and width of conidia of Fusarium moniliforme Sheldon var. subglutinans and the Fusarium under study

TYPES OF CONIDIA	FUSARIUM MONILIFORME SHELDON VAR. SUBGLUTINANS		FUSARIUM UNDER STUDY	
	length	*width*	*length*	*width*
	μ	μ	μ	μ
0-septate	15.5	3.5	14.1	3.4
1-septate	23.2	3.9	22.6	3.7
2-septate	26.2	4.2	27.0	4.1
3-septate	31.2	4.1	31.8	4.3
4-septate	40.0	3.6	40.1	3.9
5-septate	60.3	3.9	60.7	4.1
Mean	28.33	3.83	27.33	3.98
Standard deviation	13.58	0.313	13.58	0.218
Probable error of mean	±3.738	±0.079	±3.58	±0.156

Forms of fructification. The hyphae on the surface of the agar media and the aërial mycelium produced the conidia and the slimy masses or pionnotes. In older cultures on potato-dextrose agar, wart-like and grayish pink sporodochia were formed. These structures when crushed in water gave numerous conidia.

Cultural characters. The fungous growth was abundant on oatmeal, corn meal, steamed rice and potato-dextrose agar. On potato agar its growth was thin and scarce. The aërial mycelium was typically rare and varied in color in the different media.

The aërial mycelium on agar media without dextrose was scanty, short and of pale flesh color.[3] On agar media containing dextrose the growth was profuse and the color ranged from dark violet to blackish purple. The presence of dextrose to some extent affected the substratum of the medium. The color of the media was a little deeper when they contained more dextrose.

a. Cultures four days old on corn meal agar were characterized by submerged, slimy, deep lavender to dark violet and blackish purple growth with short, woolly and purplish lilac aërial mycelium. When seven days old the growth remained the same and the sub-

[3] The color nomenclature followed in these studies is that of Robert Ridgway. 1912. Color standards and color nomenclature. 43 p., 53 colored pl.; 1115 named colors. Washington, D. C.

stratum was changed from Bishop's purple to Rood's violet. When twelve-days old, the growth became thick and the substratum became Mathews' purple. When eighteen days old the growth became thick with large slimy dark violet masses of spores and purplish lilac aërial mycelium. The substratum was Mathews' purple to Bradley's violet. The same characteristics were observed when the fungus became old.

b. Cultures four days old on steamed rice were characterized with submerged, slimy, white and light mauve growth. There was scanty, short, woolly and mauvette aërial mycelium. The substratum was changed from light mauve to Mathews' purple.

When seven days old the aërial mycelium was medium dense, short, woolly and mauvette to Spinel pink. The substratum did not change in color.

When twelve days old the aërial mycelium changed from Spinel pink to lilac and amparo purple. As the culture became old the same characteristics were observed except that the growth thickened somewhat.

c. Cultures four days old on oatmeal agar were characterized by submerged slimy, white and pale pinkish buff growth with scanty, short, woolly and dirty white aërial mycelium. The substratum was changed to light mauve and pale amparo. When seven days old the substratum was changed to light mauve and pale hortense violet. In the twelve-day old culture the growth became thin and light amparo purple. The stroma was shiny in some parts with light mauve pionnotes. The substratum was changed to Mathews' purple and Bradley's violet. When twenty days old the stroma possessed dark violet pionnotes and the substratum remained Mathews' purple and Bradley's violet.

d. Cultures four days old on potato agar plus two per cent dextrose were characterized by the presence of scanty aërial mycelium. The hyphae were short, twisted, woolly and pale lavender violet in color. Slimy light buff stromata were present. The substratum was changed from pale lavender violet to Mathews' purple. When seven days old there was no change observed except that the growth was somewhat thickened. When twelve days old the aërial mycelium was changed to pale flesh color. A few petunia violet pionnotes were produced. The substratum was changed to petunia violet. When twenty days old the growth remained the same in color but the substratum became dark violet.

e. Cultures four days old on potato agar plus ten per cent dextrose were characterized by an aërial mycelium which was scanty, twisted and mauvette to light mauve. When seven days old the substratum was Mathews' purple.

When twelve days old the aërial mycelium became dense, short, woolly and lilac in color. The whole growth was a deep purplish vinaceous. The stroma was slimy and rood's violet in color. When twenty days old the aërial mycelium became scarce and purple in color. Blackish red purple pionnotes which were grouped together were produced on the stroma. The substratum became dark violet to blackish purple.

f. Cultures four days old on potato agar were characterized by an aërial mycelium which was scanty, short, and pale cinnamon pink. The substratum appeared transparent. When seven days old the substratum became sea-shell pink. When twenty days old the substratum changed to light buff and light ochraceous buff.

Test of the pathogenicity of the fungus. Inoculation experiments with the *Fusarium* were conducted by the writer. Two to five months old potted abacá seedlings of Puti-tumatagacan and Itom varieties were used. The potted abacá seedlings of each variety were divided into four lots.

Spraying with a spore suspension the injured bases of the young and furled leaf of the abacá seedlings checked by a control: Experiment 1. On April 24, 1931, seven abacá seedlings were inoculated with a heavy suspension of spores. A twelve-day old culture of the fungus was used as a source of inoculum. The fungous spores were sprayed on the pricked bases of the young and furled leaves. Three seedlings were used as checks. The control seedlings were sprayed with sterile water.

On April 28, 1931 the inoculated seedlings were infected while the controls remained free from the disease.

Experiment 2. On November 10, 1932, the experiment was repeated. Twelve potted abacá seedlings of Puti variety, about four months old, were used. The seedlings were inoculated with a twelve-day old culture of the fungus. Four seedlings were used for control. On November 14, 1932, all of the inoculated seedlings had symptoms of heart-rot while the control seedlings remained healthy.

Spraying the uninjured bases of the young and furled leaves of the abacá seedlings with a spore suspension: Experiment 1. On April 24, 1931, the leaf bases of seven abacá seedlings of Itom variety four months old were sprayed with a heavy suspension of spores. Three abacá seedlings were used as control. The leaf bases of the

control seedlings were sprayed with sterile water. On April 29, 1931 all of the inoculated plants showed definite symptoms of heart-rot while the control plants remained healthy.

Experiment 2. On November 10, 1932, twelve four months old abacá seedlings of Itom variety were inoculated. Four abacá seedlings of the same variety were used as control. On November 15, 1932 definite symptoms of heart-rot were shown by the inoculated plants while the control plants remained healthy.

Placing pieces of fungous mycelium on the injured bases of the youngest furled leaves of the abacá seedlings: Experiment 1. On April 24, 1931, seven abacá seedlings four months old were inoculated with twelve-day old culture of *Fusarium.* Spores and fungous mycelium were applied on the pricked base of the young and furled leaf. Three abacá seedlings were used for control. Sterile potato dextrose agar was applied on the pricked base of the furled leaf of the control seedlings.

On April 29, 1931 all of the inoculated seedlings were infected while the check seedlings remained healthy.

Experiment 2. On November 10, 1932, twelve, four months old seedlings of Itom variety were inoculated. Four abacá seedlings were used as control. On November 14, 1932 all of the inoculated seedlings showed heart-rot infection while the controls remained healthy.

Placing pieces of fungous mycelium on the uninjured bases of the young and furled leaves of the abacá seedlings: Experiment 1. On April 24, 1931, seven seedlings of Itom variety were inoculated with a twelve-day old culture of *Fusarium.* The fungous spores and mycelium were applied on the uninjured bases of the young and furled leaf. Three control seedlings were used. The control seedlings were treated in a manner similar to that of the inoculated plants except that sterile potato dextrose agar was used instead of fungous mycelium.

On April 29, 1931 all of the inoculated seedlings developed heart-rot but the controls remained healthy.

Experiment 2. On November 10, 1932 the experiment was repeated. Twelve abacá seedlings of Itom variety four months old were inoculated. Four seedlings were used for control. Five days after inoculation, the treated seedlings showed definite symptoms of heart-rot. The control seedlings were all free from infection.

All of the inoculated and control seedlings in each of the above experiments were placed in the moist chamber for four or five days. Under damp-chamber conditions, the inoculated seedlings showed infection by the fungus.

In four to six days after inoculation water soaked lesions were noted. These appeared as light to dark brown areas on the seedlings. The symptoms were produced on the leaf sheaths and youngest furled leaves where the spore suspension was sprayed. Larger lesions were produced on seedlings previously pricked.

The rotting of the youngest furled leaves and the leaf sheaths started from the top and advanced toward the lower portion of the pseudostem. As the disease advanced, the infected areas were transformed into soft, dark-brown tissues. Later on, yellowing, wilting, bending over and finally dying of the infected leaves occurred.

Thirty-five to forty days after inoculation, healthy leaves developed and the infected seedlings nearly recovered.

Relation of the fungus isolated by the writer from heart-rot to Fusarium moniliforme Sheldon var. subglutinans Wollenweber and Reinking

The two *Fusaria* were similar in (1) size of spores, (2) cultural characters, (3) absence of chlamydospores and (4) forms of fructifications produced on artificial media.

Size of spores. According to Ocfemia and Mendiola (1932) the 0- and 1-septate microconidia of *Fusarium moniliforme* Sheldon var. *subglutinans* ranged from 15.5 to 23.2 by 3.5 to 3.9 μ and the 2-, 3-, 4- and 5-septate macroconidia ranged from 26.2 to 60.3 by 3.6–4.1 μ. In the writer's *Fusarium* the 0- and 1-septate microconidia measured from 14.1 to 22.6 by 3.4 to 3.7 μ and the 2-, 3-, 4- and 5-septate macroconidia measured from 29.0 to 60.7 by 3.5 to 4.6 μ. The two *Fusaria* agree very closely in spore size.

Cultural characters. It was noted that there is very slight difference in the cultural characters. *Fusarium moniliforme* Sheldon var. *subglutinans* and the one isolated by the writer from heart-rot appeared similar in every medium used. The two *Fusaria* exhibited copious growth on corn meal agar, steamed rice, oatmeal and on potato dextrose agar and scanty and thin growth in potato agar. Their colors on medium of the same composition appeared similar. When compared with the color standards of Ridgway (1912) *Fusarium moniliforme* Sheldon var. *subglutinans* was slightly darker in color than the writer's *Fusarium.*

Absence of chlamydospores. In examination of the mycelium of twenty-day old cultures of *Fusarium moniliforme* Sheldon var. *subglutinans* Wollenweber and Reinking on oatmeal the writer noted small globose, thin walled and granular chlamydospore-like structures, either singly or in pairs. Microscopic examination of the writer's *Fusarium* from heart-rot of the same age and on the same medium also showed swellings of the hyphae which were globose, granular, thin walled and single. To verify the absence of chlamydospores, conidia were germinated in hanging drops of sterile water. The result showed that the fungus does not produce chlamydospores.

Forms of fructification. Examination of a twelve-day-old culture on potato dextrose agar of *Fusarium moniliforme* Sheldon var. *subglutinans* showed that conidia were produced by the submerged hyphae or by the aerial mycelium. On older cultures pionnotes were formed. Similar studies of a twelve-day-old culture of *Fusarium* from heart-rot was made and the writer found that conidia were also produced by the aerial mycelium and also pionnotes.

Morphological and cultural studies showed that the heart-rot *Fusarium*, under study was identical with *Fusarium moniliforme* Sheldon var. *subglutinans* Wr. and Rg. The fungus belongs to the section Liseola (Wollenweber, Sherbakoff, Reinking, Johann and Bailey, 1925a, and Wollenweber and Reinking, 1925b). The fungus *Fusarium moniliforme* Sheldon var. *subglutinans* Wr. and Rg., is characterized by: microconidia on aerial mycelium, 0-1-septate, thin walled, chlamydospores absent; macroconidia subpedicellate to pedicellate and 2-5-septate. The 1-septate measure $22 6 \times 3.7\,\mu$; 2-septate $29.0 \times 4.1\,\mu$; 3-septate $33.8 \times 4.6\,\mu$; 4-septate 40.1×3.9 u; and 5-septate $60.7 \times 4.2\,\mu$.

SUMMARY AND CONCLUSIONS

1. Heart-rot of abacá, or Manila hemp (*Musa* textilis Née) occurs on weakened abacá plants. It may be regarded as a secondary trouble.

2. In the present study it was found that from 10.49 to 22.1 per cent of the abacá plants infected with the bunchy-top disease die of heart-rot.

3. Root weevil, *Cosmopolites sordidus* Germar, is a serious insect pest. It causes serious damage on abacá in the field. It was found that heart-rot cases following root weevil injuries ranged from 53.3 to 90 per cent.

4. It was found that heart-rot cases following nematode infection range from 9.5 to 20.5 per cent.

5. Cutting off portions of the roots of abacá weakens the plant and predisposes it to various agencies which sometimes result in the production of heart-rot.

6. The fungus isolated from heart-rot of abacá caused rotting only under damp-chamber conditions. As soon as the seedlings were taken out of doors, they outgrew infection and recovered from the disease.

7. Infection is produced more readily on the injured than on the uninjured bases of the youngest leaves.

8. It takes from four to six days for the disease to appear after inoculation and from thirty-five to forty days for the plants to recover from the disease.

9. The fungus isolated from heart-rot cases of abacá is identical with *Fusarium moniliforme* Sheldon var. *subglutinans* Wollenweber and Reinking.

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COMPARATIVE STUDIES ON THE GROWTH AND MATURITY OF LOS BAÑOS CANTONESE AND NAGOYA CHICKENS [1]

TELESFORO TIOAQUEN

WITH ONE CHART

Two of the outstanding and popular breeds of poultry imported into the Philippines are the Cantonese and Nagoya. The Cantonese fowl was introduced into the College of Agriculture about sixteen years ago and it has readily adapted itself to its new environment. Fronda and Gonzalez (1927) stated that because of its adaptability to local conditions the Cantonese fowl may become an important factor in the development of the poultry industry in this country.

The Nagoya chicken is relatively a recent immigrant, but the indications are that it will become a close competitor of the important breeds now found in the Islands. Nagoya chickens are now profitably raised in some suburbs of Manila and in the near by provinces. Fronda and Gonzalez (1929) described the recent introduction of this new breed into the College of Agriculture from Japan. The first Nagoya birds that were hatched in the College in 1926 behaved favorably under Philippine conditions, and during later years, highly marked improvements have been noted in the shortening of the period of maturity and the productiveness of the birds.

The interest of poultry raisers in these two breeds, the Los Baños Cantonese and the Nagoya, is becoming so great that comparative studies on their growth and maturity should be timely and of value. The facts and conclusions gathered from such work may be of some help in the development of the poultry industry in the Philippines.

A number of experiments on observing and comparing the rate of growth of the Cantonese chickens with other breeds of poultry have been carried in this College. Lindayag (1918) compared the Cantonese and Native chickens and observed that the average number of days a Cantonese required to mature was 248.2. Dañgilan (1924) studied the rate of growth of Cantonese chickens and found

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that on an average the pullets laid their first eggs when they were 212.8 days old. Mendoza (1925) compared the rate of growth of Cantonese and Rhode Island Red-Cantonese crosses and recorded that the Cantonese laid their first eggs at the average age of 174 days. Ordoveza (1927) found that, on an average, Cantonese pullets from eggs hatched in December matured in 163 days; those hatched in February, in 266 days, and those hatched in April, in 220 days.

Referring to the Nagoya breed in Japan, Shinji (1927) in his paper, *On Nagoya, one of the dual-purpose poultry breeds originated in Japan,* said, in part, that, "the chickens make good broilers in two months, and surplus cockerels may be fattened and make good roasters at four months of age. Pullets lay their first egg in their sixth month." Fronda and Gonzalez (1929) writing on *The Nagoya, a new immigrant from Japan,* stated that among the four pullets produced from the thirty Nagoya eggs brought here from Japan in 1926, the earliest bird to mature laid her first egg at the age of ten months and twenty-three days and the latest maturing bird laid her first egg when twelve months and eight days old.

The present work had for its object the comparison of the rate of growth and maturity of the Cantonese and Nagoya chickens. Observations were made on three sets of birds, the first being from October 30, 1930 to July 17, 1931, the second from January 6, 1931 to September 16, 1931 and the third from March 11, 1931 to December 26, 1931. This work was conducted in the Poultry Division, Department of Animal Husbandry, College of Agriculture, Los Baños.

MATERIALS AND METHODS

A total of 255 Cantonese chicks and the same number of Nagoya chicks were used in this study. Fireless brooders made out of empty petroleum boxes were used in brooding the chicks. The chicks in each lot were kept separately in these brooders all night and during the day they were allowed to go out for feeding, drinking and exercise in yards enclosed with poultry wire-fencing.

At the age of eight weeks all the birds in each set were put into portable rearing houses and placed in grassy yards. In these houses the birds remained for four weeks, then the sexes were separated. In each set all the males from the two breeds were put together into one of the rearing houses and all the females were placed in the laying house.

The grain feed used during the first four weeks was ground corn. Then a mixture of equal amounts of palay and cracked corn was given instead of ground corn alone. The mash feed was composed, by weight, of two parts shrimp meal, two parts ground corn, and six parts rice bran. During the first four weeks, hard-boiled infertile eggs, chopped fine and mixed with the regular mash feed, were given once a day to the young chicks, allowing one egg daily for every thirty chicks. Chopped green grass was also provided. After four weeks one part copra meal by weight was added to the mash mixture.

For the greater part of the time they were under observation, the Cantonese and Nagoya chicks in each set were kept and fed together. The chicks were allowed all the feed that they would consume.

The initial weight of each chick was taken about twenty-four hours after the hatch was taken off. From the day they were first weighed to the end of the study each bird was weighed weekly. During the first four weeks a pan balance sensitive to one gram was used; for the remainder of the time an ordinary spring balance sensitive to 25 grams.

RESULTS AND DISCUSSION

Weight of day-old chicks. Table 1 gives the average weekly weights of the chicks of the three sets of hatches made in this study. This table includes only the weights of the birds before they were separated as to sex at three months of age. It may be seen that at the outset the average weight of the Cantonese chick was 24.7 grams, of the Nagoya chick, 28.2 grams, the Nagoya being 3.5 grams the heavier. In the case of the Cantonese chicks the average initial weight was doubled between the second and third weeks and much more than doubled in the third week. With the Nagoya chicks the average initial weight was doubled between the second and the third weeks, also, and slightly more than doubled in the third week. Dañgilan (1924) and Mendoza (1925) both reported that the initial average weight of Cantonese chicks was doubled at about three weeks of age; a result very similar to that observed in the study here reported.

Generally, as table 1 shows, there was not much difference in the two breeds in the gain in weight nor in the percentage of gain from the first day to the twelfth week. The Nagoya chicks during

the twelve weeks showed a higher gain in weight than the Cantonese, but a lower percentage of gain. The differences in the gains in weights during this period may be considered insignificant.

In comparing the observations on the Cantonese chicks used in this study with those on chicks used by previous workers, it was found that Lindayag (1918) reported 26.5 grams as the average weight of Cantonese chicks after twenty-four hours. Dañgilan's chicks (1924) averaged 28.6 grams in weight after forty-eight hours. Resananda (1925) reported 29.7 grams as the weight of the chicks when forty-eight hours old, this weight representing the average weight of chicks that were hatched from March, 1923 to February, 1924 and consisting of sixteen hatches. Mendoza's (1925) chicks weighed 28.3 grams after one day. Ordoveza (1927) reported 27.6 grams for one-day old chicks hatched in December, 25.4 grams for chicks hatched in February, and only 19.4 grams for those hatched in April. As may be seen the Cantonese chicks used in this work, weighing 24.7 grams at the age of one day, averaged a little lighter in weight than most of those reported by the previous workers named.

In the following weeks, however, the average Cantonese chick raised in this experiment made such rapid growth that after six weeks it outweighed most of the chicks reported by the previous workers cited. In the seventh week Lindayag's chicks averaged 172.2 grams in weight; Dañgilan reported 143.5 grams; Mendoza recorded 206.1 grams; and Ordoveza in his three sets of experiments reported 163.7 grams, 129.1 grams and 141.3 grams, respectively. In the present work the average weight of the Cantonese chicks at the same age was 175.6 grams, second to the highest weight reported by Mendoza. In the eighth week, Lindayag reported 212.2 grams, as the average weight for his Cantonese chicks; Dañgilan, 175.5 grams; Mendoza, 251.4 grams, and Ordoveza in his three sets of work obtained 190.2 grams, 155.1 grams and 187.4 grams. In the present work, the Cantonese chicks at this age averaged 212.6 grams which was again second to that reported by Mendoza which was the highest weight given for this age.

Comparative growth of males and females: The males. Tables 2 and 3 give the average weekly weights and gains in weight in the three sets of observations made. As shown in these tables, the average initial weight of the male Cantonese was 24.9 grams and the male Nagoya, 28.6 grams, giving a difference of about 4 grams in favor of the Nagoya. Throughout the period of this work the Nagoya male averaged heavier than the Cantonese male, although during the first few weeks the differences were very slight. The

highest weekly gain, 97.4 grams, was by the Cantonese males during the eighteenth week. The Nagoya males made the highest weekly gain, 115.9 grams, in the twenty-fourth week. In the eighth week the average weight of the Cantonese males was 229.9 grams, the Nagoya males, 262.9 grams; in the sixteenth week the Cantonese averaged 805.5 grams and the Nagoya, 859.4 grams; in the twenty-fourth week the Cantonese weighed 1401.5 grams, the Nagoya, 1538.6 grams, and in the thirty-second week the Cantonese weighed 1703.7 grams and the Nagoya, 1965.2 grams.

The females. Looking at the averages given in table 2 it may be noted that, on the whole, until maturity the weekly weights of the Cantonese females were always lower than the weights of the Nagoya females during the corresponding periods given in table 3. The initial weight of the Cantonese females was 24.6 grams and the Nagoya, 27.9 grams, giving a difference of 3.3 grams in favor of the Nagoya. After eight weeks the average weight of the Cantonese was 211.9 grams and of the Nagoya 237.5 grams. After sixteen weeks the Nagoya pullets registered 668.3 grams and the Cantonese, 714.0 grams; in the twentieth week the average weight of the Cantonese was 925.8 grams, the Nagoya, 963.2 grams; and in the twenty-fourth week the Cantonese averaged 1127.3 grams in weight and the Nagoya, 1246.2 grams.

Very similar to the Cantonese males the Cantonese females made their highest percentages of gains in weight during the period from the first to the fifteenth week, with the highest percentage, 38.7, in the second week. The lowest percentage was in the twenty-third week. The Nagoya chicks presented the same similarity; the Nagoya females like the Nagoya males made their highest percentages of gains during the period from the first to the thirteenth week, and the highest percentage of gain, 46.7, in the fifth week. The lowest percentage was produced in the twenty-first week.

Chart 1 presents graphically the average weekly weights of both the Cantonese and Nagoya males and females. The chart shows that in the first five weeks the average weights of the males and females of both breeds were very close. Generally speaking, according to the results obtained in this study, the Nagoya chicks grew a little faster than the Cantonese chicks, although the difference may be considered insignificant.

Table 4 gives the monthly mean weights and their corresponding probable errors. The table shows that as the weights increased there were corresponding gradual increases in the probable errors on account of the fact that the greater the weight the greater is the

chance of increasing the error made in weighing. By reference to this table, it may be seen that during the first day, fourth, eighth, twenty-fourth, twenty-eighth and thirty-second weeks the differences of weights between the Nagoya and the Cantonese males were found

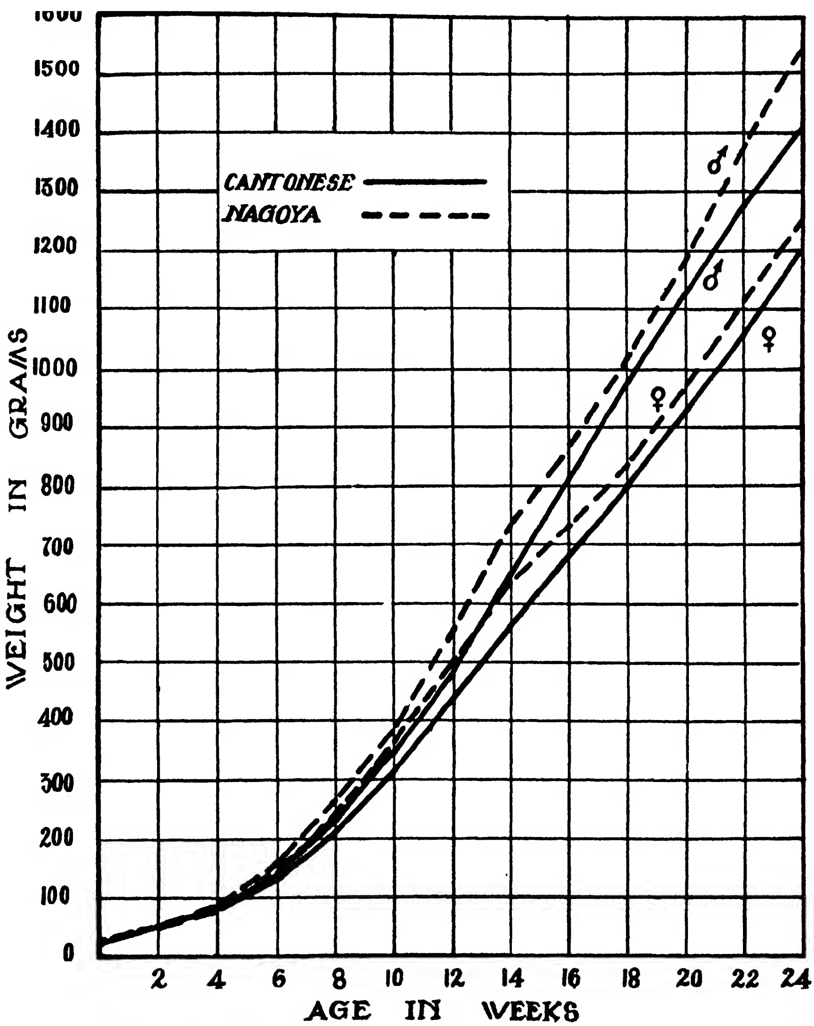

Chart 1.—Average weekly weights of Cantonese and Nagoya males and females up to twenty-four weeks of age.

to be significant, and insignificant only in the twelfth, sixteenth and twentieth weeks. With regard to the Nagoya and the Cantonese females all the differences in weights were significant, except in the twentieth week. This table, therefore, shows that the Nagoya

chickens made better and more significantly important mean monthly weights than the Cantonese did during the same time.

Further examination of table 4 will reveal that in spite of the increase of the probable error as the weights increased, there was, generally, remarkably large gradual increases in the differences of weights of both the Nagoya and Cantonese, either male or female, so that the proportion of the difference and its probable error became greater until maturity. Since the differences generally increased and were very distinctly significant, it may then be assumed that in general the Nagoya had more marked gains in weight and size than the Cantonese and that this condition became more and more evident up to maturity.

Growth of feathers. Careful observations on the growth of the feathers were made. At about four weeks of age the average female Cantonese chick used in this work had grown its primary wing feathers and the secondary wing feathers were beginning to form. The males at this age, with some exceptions, showed scarcely any feather development. At eight weeks, the average female Cantonese was fully feathered. The male Cantonese, on the other hand, were still feathering. Their wing, back, saddle and side feathers had grown almost fully, with the neck and tail still showing new and undeveloped feathers. At this age the birds often flew or ran rapidly whenever they were called for feeding. At twelve weeks old, the average male and female Cantonese were fully feathered.

The Nagoya chicks at four weeks old showed almost no development of feathers. At eight weeks old, the female Nagoya chicks appeared similar to the male Cantonese as regards feather covering. The average male Nagoya had grown only its wing, back and part of the saddle feathers. At the age of twelve weeks the Nagoya male and female showed full feather growth.

Sex. At three months of age the sex in Cantonese and Nagoya could easily be distinguished by external appearance. Even as early as two months the sexes in Cantonese could be distinguished by the size of their combs and wattles, and by examination of the saddle and back feathers. The combs, wattles and feathers of the Nagoya chicks developed much later than the Cantonese, thereby making it difficult at this period to separate them according to sex. Although the Nagoya birds used in this study were actually separated according to sex when three months old, among the Cantonese the males were determined when they were two months of age by their more developed combs and wattles and by their pointed and long saddle and back feathers.

Maturity. The laying of the first egg was used as a guide in the determination of maturity among the pullets. Fronda (1928) stated that "maturity as applied to fowls means the laying of the first egg." Also, according to Hays and Bennett (1923), egg laying may be considered as a manifestation of sexual maturity in the pullet.

Table 5 gives the ages in days of the pullets at maturity. The first set of the observations showed the least number of days for the pullets to reach maturity; the second set the next number, and the third set the highest number of days. The mean or average ages at maturity of the Cantonese were 154, 191 and 193 days, in the first, second and third sets, respectively, with an average of 179 $\pm$ 8.5 days. Of the Nagoyas the three means were 175, 204 and 224 days with an average of 201.0 $\pm$ 9.6 days.

It may be seen also in table 5 that in the sixth month the percentages of birds that were laying in the flocks of Cantonese were: first set, 100 per cent, second set, 18.6 per cent and in the third set, 23.5 per cent. At the same age, in the first set of the Nagoyas there was 76.4 per cent laying birds; second set, 6.9 per cent; and in the third set there was none. As the birds were never given forced feeding that might have stimulated an early maturity, but instead were kept, so far as possible, under the same types of conditions, management and care, an explanation for the great differences of time to maturity recorded in the three sets of each breed studied must be sought in the different weather conditions and seasons of the year under which the birds were grown.

The first hatch was taken off on November 21, 1930, so the birds were about seven months old at the end of May, 1931. The first hatch, therefore, was reared under the most ideal conditions. The second hatch was taken down on January 28, 1931, hence, the birds were four months old when the rainy season began, so that a considerable portion of their lives from chick to maturity was spent in the hottest part of the dry season and in the rainy period. The third set was taken down on April 14, 1931 and the observations closed in December, 1931. It has been the experience of poultrymen in the Philippines that chicks reared during the hottest part of the dry season and during the months of heavy rainfall of the year are not as vigorous as those that are grown during the season when the weather was not too wet and the rainfall fairly distributed. Ordoveza (1927) made record of this experience in the three sets of

hatches he made. A similar result was obtained in the present work. One important thing, however, that may be noted in table 5 is that, under whatever conditions the birds were reared, the Cantonese matured earlier than the Nagoya.

Table 6 is presented to show the percentages of birds maturing at different periods of the experiment. At the age of twenty-one weeks there were in the Cantonese 3 out of 90 birds or 3.3 per cent, and in the Nagoya 2 out of 76 birds or 2.6 per cent, that had laid their first egg. At the age of twenty-four weeks in the Cantonese 35 out of 90 birds or 38. 9 per cent and in the Nagoya 3 out of 76 birds or 3.9 per cent had reached maturity. In the twenty-eighth week in the Cantonese 70 out of 90 or 77.8 per cent and in the Nagoya 37 out of 76 or 48.6 per cent had laid their first egg. The period with the highest number of maturing birds in the Cantonese was between the twenty-second and the twenty-third weeks, and in the Nagoya between the twenty-fourth and twenty-fifth weeks.

Comparative weights of eggs. Additional observations were made to determine the average weight of the first five eggs laid by the pullets (*see* table 7). By reference to this table it may be noted that the Cantonese pullets under the same age laid lighter and smaller eggs than the Nagoya pullets. Furthermore, the earlier the pullets matured the smaller were the eggs laid and as the pullets advanced in age there was a corresponding increase in the size of the eggs produced at maturity.

The original eggs from Japan from which the College Nagoya flock began had an average weight of 62.0 grams. In the present work, the average weight of the first five eggs that the Nagoya pullets laid was only 39.4 grams.

Mortality. Table 8 gives the number of dead chicks and the percentages of mortality up to the twelfth week. Dañgilan (1924) and Mendoza (1925) both reported that the period of highest mortality among Cantonese chicks was within the first eight weeks. The same result was observed in the present experiment, with the heaviest mortality within the first month. Among the Cantonese chicks, the highest mortality was recorded between the fourth and fifth weeks, and among the Nagoyas, the largest number of deaths was registered between the third and fifth weeks. From the fifth to the twelfth week most of the deaths were due to roup or chicken pox. From the twelfth to the thirty-second week there were but few losses, most of which were probably due to stray cats or hawks. One Nagoya pullet at twenty-nine weeks of age was attacked by a

disease which could not be identified; she was removed from the flock and killed. According to the results of observation on mortality, the Nagoyas showed less resistance to the ill effects of local conditions, yielding more easily to disease and unfavorable weather than the Cantonese.

SUMMARY OF CONCLUSIONS

1. The average weight of baby chicks of the Cantonese breed was 24.7 grams and of the Nagoya, 28.2 grams.

2. The average initial weights of both the Cantonese and Nagoya chicks were doubled between the second and the third weeks.

3. The most rapid growth among the Cantonese chickens was observed to be from the first to the fifteenth week, with the highest percentage in the second week, while the most rapid growth among the Nagoya chickens was from the first to the thirteenth week with the highest percentage in the fifth week.

4. In general, the Nagoya chicks made greater increases in weight than the Cantonese chicks.

5. The Nagoya males made the highest average weekly weights.

6. The Cantonese chicks developed their feathers earlier than the Nagoya chicks.

7. Sex could be easily distinguished among the Cantonese chicks when they were about two months old; with the Nagoya, when about three months old.

8. Cantonese pullets laid their first egg at the average age of 179 days. The Nagoyas laid their first egg at the average age of 201 days.

9. Early-maturing birds laid smaller first eggs than the late-maturing birds.

10. The Cantonese pullets laid smaller and lighter eggs than the Nagoya pullets.

11. Both Cantonese and Nagoya breeds showed the highest mortality during the first eight weeks.

12. Nagoya chicks showed a higher mortality than Cantonese.

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TABLE 1

Average weekly weights of Cantonese and Nagoya chicks
(Average of first, second and third sets)

AGE	CANTONESE				NAGOYA			
	Number of chicks	Av. weekly weights	Av. weekly gain	Gain	Number of chicks	Av. weekly weights	Av. weekly gain	Gain
		grams	*grams*	*per cent*		*grams*	*grams*	*per cent*
1 day	255	24.7	—	—	255	28.2	—	—
1 week	247	31.3	6.6	26.7	246	35.3	7.1	25.2
2 weeks ...	237	43.4	12.1	38.6	236	47.1	11.8	33.4
3 weeks ...	232	58.5	15.1	34.7	224	61.7	14.6	30.9
4 weeks ...	227	74.9	16.4	28.0	199	84.3	22.6	36.6
5 weeks ...	215	101.3	26.4	35.2	181	118.3	34.0	40.3
6 weeks ...	211	131.5	30.2	29.8	180	156.8	38.5	32.5
7 weeks ...	208	175.6	44.1	33.5	175	211.6	54.8	34.9
8 weeks ...	200	212.6	37.0	21.1	165	245.7	34.1	16.1
9 weeks ...	196	269.4	57.2	26.9	165	302.0	56.3	22.9
10 weeks ...	185	327.8	58.4	21.7	157	373.2	89.4	31.5
11 weeks ...	185	390.8	63.0	19.2	157	442.5	69.3	18.6
12 weeks	178	460.1	69.4	17.7	152	514.6	72.1	16.2

TABLE 2

Average weights of Cantonese males and females
(Average of first, second and third sets)

AGE	NUMBER OF BIRDS		AV. WEEKLY WEIGHT		AV. WEEKLY GAIN		GAIN	
	Male	Female	Male	Female	Male	Female	Male	Female
			grams	*grams*	*grams*	*grams*	*per cent*	*per cent*
1 day	87	91	24.9	24.6	—	—	—	—
1 week	87	91	32.7	30.7	7.8	6.1	31.3	24.7
2 weeks ...	87	91	46.6	42.6	13.9	11.9	42.5	38.7
3 weeks ...	87	91	63.2	58.9	16.6	16.3	35.6	38.2
4 weeks ...	87	91	80.3	75.3	17.1	16.4	27.0	27.8
5 weeks ...	87	91	109.8	102.0	29.5	26.7	36.7	35.4
6 weeks ...	87	91	139.7	132.1	29.9	30.1	27.2	29.5
7 weeks ...	87	91	189.3	174.1	49.6	42.0	35.5	31.7
8 weeks ...	87	91	229.9	211.9	40.6	37.8	21.4	21.7
9 weeks ...	87	91	288.3	261.6	58.4	49.7	25.4	23.4
10 weeks ...	87	91	344.6	316.7	56.3	55.1	19.5	21.0
11 weeks ...	87	91	412.8	375.8	68.2	59.1	19.7	18.6
12 weeks ...	87	91	484.5	437.9	71.7	62.1	17.3	16.5
13 weeks ...	87	91	577.0	508.5	92.5	70.6	19.0	16.1
14 weeks ...	86	90	654.1	559.7	77.1	51.2	13.4	10.0
15 weeks ...	86	90	736.3	623.1	82.2	63.4	12.5	11.3
16 weeks ...	86	90	805.5	668.3	69.2	45.2	9.3	7.2
17 weeks ...	86	90	884.0	718.9	78.5	50.6	9.7	7.5
18 weeks ...	86	90	981.4	795.3	97.4	76.4	11.0	10.6
19 weeks ...	86	90	1053.4	872.5	72.0	77.2	7.3	9.7
20 weeks ...	86	90	1126.4	925.8	73.0	53.3	5.1	6.1
21 weeks ...	83	87	1204.2	977.3	77.8	51.5	6.9	5.5
22 weeks ...	83	78	1274.1	1049.0	69.9	71.7	5.8	7.3
23 weeks ...	83	61	1341.9	1065.2	67.8	16.2	5.3	1.5
24 weeks ...	82	55	1401.5	1127.3	59.6	62.1	4.4	5.8
25 weeks [a] ...	82	—	1465.5	—	64.0	—	4.5	—
26 weeks ...	82	—	1506.7	—	41.2	—	2.8	—
27 weeks ...	82	—	1549.4	—	42.7	—	2.8	—
28 weeks ...	82	—	1580.2	—	30.8	—	1.9	—
29 weeks ...	82	—	1629.0	—	48.8	—	3.0	—
30 weeks ...	82	—	1650.6	—	21.6	—	1.3	—
31 weeks ...	82	—	1665.8	—	15.2	—	0.9	—
32 weeks ...	82	—	1703.7	—	37.9	—	2.2	—

[a] Weighing of the females was discontinued.

TABLE 3

Average weekly weights of Nagoya males and females (Average of first, second and third sets)

AGE	NUMBER OF BIRDS		AV. WEEKLY WEIGHT		AV. WEEKLY GAIN		GAIN	
	Male	Female	Male	Female	Male	Female	Male	Female
			grams	*grams*	*grams*	*grams*	*per cent*	*per cent*
1 day	75	77	28.6	27.9	—	—	—	—
1 week	75	77	36.6	35.4	8.0	7.5	27.9	26.8
2 weeks ...	75	77	51.5	47.2	14.9	11.8	40.7	33.3
3 weeks ...	75	77	68.7	63.2	17.2	16.0	33.3	33.8
4 weeks ...	75	77	88.9	85.6	20.2	22.4	29.4	35.4
5 weeks ...	75	77	128.9	117.7	40.0	32.1	44.9	46.7
6 weeks ...	75	77	168.0	156.3	39.1	38.6	30.3	32.7
7 weeks ...	75	77	225.1	205.2	57.1	48.9	33.9	31.3
8 weeks ...	75	77	262.9	237.5	11.2	26.0	4.9	12.6
9 weeks ...	75	77	310.6	296.6	74.3	65.4	31.4	28.2
10 weeks ...	75	77	379.9	365.5	69.3	68.9	22.3	23.2
11 weeks ...	75	77	455.1	435.1	75.2	69.6	19.8	19.4
12 weeks ...	75	77	528.0	503.9	72.9	68.8	15.8	15.8
13 weeks ...	75	77	643.9	577.7	115.9	73.8	21.9	14.6
14 weeks ...	75	77	726.0	619.8	82.0	42.1	7.4	12.7
15 weeks ...	75	77	792.3	668.8	66.3	49.0	9.1	7.9
16 weeks ...	72	77	859.4	714.0	80.6	45.2	10.3	6.7
17 weeks ...	72	77	911.8	751.3	52.4	37.3	6.1	5.2
18 weeks ...	71	76	1008.1	830.6	93.8	79.3	10.2	10.5
19 weeks ...	69	76	1099.0	898.7	91.0	68.1	9.0	8.1
20 weeks ...	69	76	1174.6	963.2	75.5	64.5	6.8	7.2
21 weeks ...	69	74	1266.2	1018.2	91.6	38.0	7.7	3.9
22 weeks ...	69	74	1373.2	1111.8	107.0	93.6	8.4	9.2
23 weeks ...	68	73	1460.3	1181.3	87.1	69.5	6.3	6.2
24 weeks ...	68	73	1538.6	1246.2	78.3	64.9	5.3	5.4
25 weeks [a] ...	67	—	1613.4	—	74.8	—	4.9	—
26 weeks ...	67	—	1671.6	—	58.2	—	3.6	—
27 weeks ...	67	—	1724.9	—	53.3	—	3.1	—
28 weeks ...	65	—	1791.5	—	66.6	—	3.1	—
29 weeks ...	65	—	1845.4	—	53.9	—	3.0	—
30 weeks ...	64	—	1896.9	—	51.5	—	2.7	—
31 weeks ...	64	—	1928.5	—	43.7	—	2.3	—
32 weeks ...	64	—	1965.2	—	36.7	—	1.9	—

[a] Weighing of the females was discontinued.

TABLE 4

Showing importance of differences with respective probable errors of the mean weights of Nagoya and Cantonese chickens compared at different ages

AGE	MEAN WEIGHTS OF MALES			MEAN WEIGHTS OF FEMALES		
	Nagoya	Cantonese	Difference	Nagoya	Cantonese	Difference
1 day	28.5 ± 0.234	24.9 ± 0.211	3.6 ± 0.315	28.0 ± 0.234	24.5 ± 0.221	3.5 ± 0.321
4 weeks ..	90.0 ± 1.270	80.5 ± 1.438	9.5 ± 1.918	85.5 ± 1.505	75.4 ± 1.482	10.2 ± 2.112
8 weeks ..	263.7 ± 4.328	229.4 ± 4.899	34.4 ± 6.537	239.2 ± 4.335	212.6 ± 5.058	26.6 ± 6.661
12 weeks ..	526.9 ± 11.168	484.4 ± 9.386	42.5 ± 14.588	504.8 ± 9.585	437.5 ± 8.997	67.3 ± 13.145
16 weeks ..	857.8 ± 17.245	806.1 ± 14.379	51.7 ± 22.453	713.5 ± 11.301	665.9 ± 10.860	47.6 ± 15.672
20 weeks ..	1171.9 ± 19.825	1129.1 ± 17.176	42.8 ± 26.230	962.3 ± 14.963	927.3 ± 14.288	34.9 ± 20.689
24 weeks ..	1439.6 ± 20.055	1402.2 ± 17.834	137.4 ± 26.837	1247.8 ± 17.224	1127.3 ± 21.422	120.5 ± 27.487
28 weeks ..	1793.2 ± 20.309	1581.0 ± 14.938	212.3 ± 25.210	—	—	—
32 weeks ..	1966.8 ± 21.500	1702.2 ± 16.095	264.5 ± 26.855	—	—	—

TABLE 5

Showing age of maturity in days [a]

	CANTONESE				NAGOYA			
	First set	Second set	Third set	Average	First set	Second set	Third set	Average
Number of birds that laid eggs ...	30	43	17	30	17	42	14	24
Age of earliest maturing bird	140	156	176	157.4 ± 7.01	164	167	189	173.3 ± 5.26
Age of latest maturing bird	167	237	232	212.0 ± 15.18	202	237	256	231.6 ± 11.00
Mode age of maturity	160	175	194	176.3 ± 6.61	168	185	231	194.6 ± 12.68
Mean age of maturity	154	191	193	179.3 ± 8.50	175	204	224	201.0 ± 9.58
Percentage of flock laying at 24 weeks	100	18.6	23.5	37.5	76.4	6.9	0.0	27.7

[a] First set—Taken down November 21, 1930.
Second set—Taken down January 28, 1931.
Third set—Taken down April 14, 1931

TABLE 6

Showing percentages of birds laying

AGE	CANTONESE			NAGOYA		
	Total number of birds	Total number of birds laying	Percentage	Total number of birds	Total number of birds laying	Percentage
20 weeks	90	—	—	76	—	—
21 weeks		3	3.3		2	2.6
22 weeks		12	13.3		2	2.6
23 weeks		29	32.2		3	3.9
24 weeks		35	38.9		3	3.9
25 weeks		39	43.3		21	27.6
26 weeks		50	55.5		21	27.6
27 weeks		60	66.6		35	46.0
28 weeks		70	77.8		37	48.6
29 weeks		74	82.2	75 [a]	42	55.3
30 weeks		75	83.3		44	57.9
31 weeks		78	86.7		46	60.5
32 weeks		85	94.4		50	65.7
33 weeks		86	95.5		56	73.7
34 weeks		87	96.7		61	80.3
35 weeks		90	100.0		72	94.7
36 weeks		—	—		74	97.3
37 weeks		—	—		75	98.7

[a] One Nagoya pullet became sick in the twenty-ninth week and was killed.

TABLE 7

Showing the averages of the average weights of the first five eggs laid

	NUMBER OF BIRDS THAT LAID		AVERAGE OF AVERAGE WEIGHT IN GRAMS	
	Cantonese	Nagoya	Cantonese	Nagoya
First set	30	17	27.4	34.8
Second set	43	42	34.3	40.2
Third set	17	14	34.6	43.2
Average	—	—	32.1	39.5

TABLE 8

Number of dead chicks and percentage of mortality up to the twelfth week

PERIOD	CANTONESE			NAGOYA		
	Number of chicks	Number of dead chicks	Percentage of mortality	Number of chicks	Number of dead chicks	Percentage of mortality
1 day	255	—	—	255	—	—
1 week	247	8	3.1	246	9	3.5
2 weeks	237	10	4.0	236	10	4.1
3 weeks	232	5	2.1	224	12	5.1
4 weeks	227	5	2.1	199	25	11.2
5 weeks	215	12	5.3	181	18	9.0
6 weeks	211	4	1.9	180	1	0.5
7 weeks	208	3	1.4	175	5	2.8
8 weeks	200	8	3.8	165	10	5.7
9 weeks	196	4	2.0	165	0	0.0
10 weeks	185	11	5.6	157	8	4.8
11 weeks	185	0	0.0	157	0	0.0
12 weeks	178	7	3.8	152	5	3.2
Total	—	77	30.2	—	103	40.9

THE AMOUNT OF RESIDUAL ARSENIC ON LEAFY VEGETABLE CROPS SPRAYED AND DUSTED WITH ARSENICAL INSECTICIDES [1]

JUAN N. SAMSON

Vegetables can not be raised without insect depredation and destruction by disease. To prevent, or at least to lessen these losses, control measures should be adopted. Leaf-eating insect pests can be controlled effectively by arsenical insecticides, such as lead arsenate, calcium arsenate and Paris Green.

Arsenical compounds are very poisonous; the lowest fatal dose for human beings (Winslow, 1919) is 1.5 grains or .0972 gram of arsenic as As_2O_3. Vegetables sprayed or dusted with arsenical insecticides may retain arsenic in amounts which might prove injurious to the consumer. A perusal of the available literature reveals that no quantitative estimate of residual arsenic on vegetables sprayed and dusted with arsenical insecticides in the Philippines has been published. Hence, the importance of the work here reported is the information it will furnish as to the possibility of improving the raising of vegetable crops in the Islands by the use of arsenical insecticides without danger to the consumer.

REVIEW OF LITERATURE

According to Bertin-Sans and Ros, as cited by Lynch, McDonnell, Haywood, Quintance and Waite (1922), "the chief danger in the use of arsenicals arose from mistakes due to carelessness and that if suitable regulations were enforced no danger was to be feared."

Bourcart (1913) states that the poison does not enter into the treated plant. Within twenty to twenty-four days, the poison remaining on the surface wholly disappears.

Lynch, McDonnell, Haywood, Quintance and Waite (1922) concluded from the results of their analyses, that to avoid excessive

[1] Thesis presented for graduation, 1933, with the degree of Bachelor of Science in Agriculture from the College of Agriculture, No. 361. Experiment Station contribution No. 907. Prepared in the Department of Agricultural Chemistry under the direction of Mr. Ramon A. Cruz.

amounts of spray residue on vegetables, the spray schedules recommended by the bureaus of Entomology and Plant Industry of the United States should be followed.

Davis, as cited by Lynch, McDonnell, et al., analyzed celery that had been sprayed with Paris green at the rate of one pound (.45 kgm.) to 175 gallons (662.38 liters) of water. The samples were washed and prepared as for market. The results of his determinations were as follows: sprayed once and sprayed twice gave .0244 grain (1.56 mgm.) and .0368 grain (2.36 mgm.) of As_2O_3 per pound (.45 kgm.) of celery, respectively.

The result of O'Kane, Hadley and Osgoods' experiment, as cited by Lynch, McDonnell, et al., gave the following amounts of arsenic (calculated as As_2O_3) on vegetables sprayed with dry lead arsenate equivalent to 3 pounds (1.35 kgm.) of lead arsenate paste to 50 gallons (189.25 liters) of water, "cabbage gathered 2 and 8 days after spraying, from 43.5 to 51.4 milligrams per head; and lettuce gathered 1 and 6 days after spraying, from 1.6 to 10.6 milligrams per head."

Robinson and Hartman (1927) working on apples stated that "there are wide variations in the amount of spray residue present on individual fruits, even when they have received the same spray treatment during the season." In their analyses of two lots of fruit from the same tree, they found .06 grain (3.85 mgm.) of As_2O_3 per pound (.45 kgm.) of fruit in one case and .09 grain (5.75 mgm.) per pound (.45 kgm.) of fruit in the other.

Hartzell and Wilcoxon (1927) following the Gutziet method of analysis worked on 47 apples from trees sprayed five times with lead arsenate at Yonkers, New York. They found an average of .173 mgm. and a maximum of .704 mgm. of arsenic trioxide per kilogram of fruit.

THE PRESENT WORK

The object of the present work was to find the amount of residual arsenic on leafy vegetable crops sprayed and dusted with arsenical insecticide.

The investigation was begun on April 1, 1932 and terminated February 15, 1933.

The vegetables were raised in the College of Agriculture, Rural High School Reservation. Chemical analyses were performed in the laboratory of the Department of Agricultural Chemistry of the College of Agriculture.

MATERIALS AND EQUIPMENT

Leafy vegetable crops

The vegetables used were:

Lettuce, *Lactuca sativa* Linn. var. *Grand Rapids.*
Cabbage, *Brassica oleracea* Linn. var. *Burpee's all head early.*
Pechay, *Brassica cernua* (Thumb.) Forbes and Hemsl. var. *Cabbage Head.*
Celery, *Apium graveolens* Linn. var. *Golden Self blanching.*
Mustard, *Brassica integrifolia* (West) O. E. Schulz. var. *Southern Giant Curled.*
Onsoi, *Apium* spp.

Dusting materials

Lead arsenate powder	2 parts by weight
Air slaked lime	10 " " "

Spraying materials

Lead arsenate powder	300 grams
Quick lime	100 "
Water	100 liters

Apparatus

In addition to the apparatus required to carry out an ordinary quantitative analysis, a small Gutziet apparatus was also used.

Plots

The plots were seven meters long and one meter wide. The distances of planting, as recommended by Elayda, and Morada (1928), were followed and are here given: pechay and mustard, 50 cm. apart; cabbage, 60 cm. apart in each row; lettuce, 25 cm. between the rows and 25 cm. apart in rows; celery, 30 cm. between the rows and 20 cm. spacing in the row; onsoi was sown in rows 30 cm. apart.

EXPERIMENTS

Spraying and dusting

The vegetables were sprayed late in the afternoon after the leaves regained their turgidity and dusted with arsenical insecticides early in the morning when the leaves were still moist with dew and there was no breeze.

Spraying and dusting were carried out in accordance with Uichanco's recommendation, (Uichanco, 1932) and both operations were performed on the same date.

The amount of insecticides used and the length of time spent in spraying and dusting were noted.

The frequency of spraying and dusting was determined by the severity of attack by the insect pests and by the weather conditions.

The vegetables were harvested on the same day. They were prepared as for market by cutting off the roots and the old dried leaves.

Method of analysis of the residual arsenic

Representative samples of the vegetables were taken and individual heads of pechay, cabbage and mustard were analyzed; with lettuce, celery and onsoi two or more heads were analyzed. The plants were chopped into small pieces with a large sharp knife so the sample could be well mixed. From this prepared sample, the moisture was determined and the remainder was dried in an oven with temperature at 60°C., gradually increasing to 100°C. From these dried samples, the rest of the analyses were made.

The modified Gutziet method of determining small amounts of arsenic as recommended by Scott (1925) was used.

Control determinations were made also with untreated plants. The figures reported are for residual arsenic.

RESULTS AND DISCUSSION

Table 1 shows the amount of residual arsenic in the plant receiving treatments. The figures arc averages of at least two concordant determinations and those used in this discussion, unless otherwise stated, are expressed in mgm. of As_2O_3 per kgm. of dry material. It may be seen in the table that the amount of residual arsenic is dependent on the frequency of application of insecticide. In the first set of dusting, using cabbage for the material, where six applications were made and the vegetable was harvested 13 days after the date of last application, a range of from 33.1 to 66.08 mgm. was found, giving an average of 46.88 mgm. for the set; whereas, in the second trial using the same plant with three applications and harvesting 7 days after date of last application, a range of from 5.83 to 10.86 mgm, was obtained, giving an average of 7.39 mgm.. Where spraying was used, a range of from 39.96 to 109.70 mgm., giving an average of 56.18 mgm. for the first set was found; whereas, for the same treatment in the second set a range of .39 to 2.01 mgm. of arsenic was obtained, giving an average of 1.48 mgm.

Pechay dusted twice and harvested 5 days after the last application contained residual arsenic varying from 9.24 to 21.98 mgm. giving an average of 15.66 mgm. Pechay, sprayed twice and ex-

posed to the same conditions, on analysis gave arsenic in amounts ranging from 9.26 to 22.80 mgm. with an average of 16.97 mgm. In the second set of experiments, using the same vegetable dusted twice and harvested 25 days after date of last application, residual arsenic was found to vary from traces to none at all.

In the first set of experiments lettuce which was dusted once and harvested 12 days after application contained residual arsenic which varied from 1.74 to 3.81 mgm., with an average of 2.89 mgm. On the same vegetable in the second set of experiments dusted once and harvested 6 days after application of the insecticides, a range of from 15.37 to 29.12 mgm. with an average of 21.59 mgm. was found.

Where spraying was done on lettuce for the first set a range of from traces to 4.71 mgm., giving an average of 3.19 mgm. of residual arsenic was found. For the same treatment in the second set, a range of 35.93 to 40.20 mgm. was found, giving an average of 38.20 mgm.

Mustard in the first set of experiments, which was dusted twice and harvested 13 days after the last application, contained residual arsenic varying from 5.04 to 21.25 mgm., giving an average of 11.49 mgm. In the second set of experiments with the same vegetable dusted twice and harvested 18 days after the last application, a range of from 3.05 to 18.05 mgm. was found, giving an average of 8.36 mgm.

For the first set, where spraying was done on mustard a range of from 25.43 to 42.97 mgm., giving an average of 37.07 mgm. of residual arsenic was found. For the same treatment in the second set, a range of 3.44 to 20.88 mgm. of arsenic was found, giving an average of 10.22 mgm.

In the first set of experiments, celery which was dusted once and harvested 22 days after application of the insecticides, contained residual arsenic which varied from 2.76 to 3.61 mgm., with an average of 3.06 mgm. In the second set of experiments, with the same vegetable dusted once and harvested 20 days after application, a range of from traces to 5.97 mgm. was found, giving an average of 4.09 mgm.

In the first set, where spraying was done on celery a range of from 3.49 to 4.13 mgm., giving an average of 3.77 mgm. of residual arsenic was found. For the same treatment in the second set, a range of 12.43 to 21.04 mgm. of residual arsenic was found, giving an average of 16.28 mgm.

Onsoi, dusted once and harvested 16 days after application, contained residual arsenic varying from 2.60 to 3.77 mgm., giving an average of 3.17 mgm. The same vegetable sprayed once and exposed to the same conditions, on analysis gave arsenic in amounts ranging from 3.42 to 4.19 mgm., with an average of 3.85 mgm.

In the second set of experiments, using the same vegetable dusted once and harvested 8 days after application of insecticides, residual arsenic varied from 2.83 to 7.40 mgm., giving an average of 4.40 mgm. The same vegetable, sprayed once and exposed to the same conditions, gave residual arsenic in amounts ranging from 18.76 to 25.42 mgm., giving an average of 21.38 mgm.

To determine whether or not dusting and spraying operations would be a paying proposition, the amount of arsenicals and the cost of operation were computed. The results are shown in table 2.

The writer paid ₱1.00 per kgm. for lead arsenate in Botica Boie, Manila and calcium oxide cost ₱.03 per 10 grams in the College of Agriculture chemistry stock room. The cost of labor was computed on a wage of ₱.10 an hour. From this computation, the cost of material and operation for 100 plants of the different vegetables used in the experiment was computed. From the data it will be found that it cost more to dust plants than to spray them. The treatment was found expensive with cabbage, as the plant was treated more frequently than the other vegetables. It may also be found from the table that even if only one application had been made, the same operation would vary in cost with the different plants because of the different amounts required, depending on the nature of the plants. One dusting on onsoi cost ₱.04 per 100 plants. Six dustings on cabbage cost ₱1.10 per 100 plants. One spraying on onsoi cost ₱.02 per 100 plants. Six sprayings on cabbage cost ₱0.55 per 100 plants.

To find whether or not the treatments affect the yield, the same number of plants, treated and untreated, in a set planted in plots side by side were weighed. The results are given in table 3. Studying the data in this table, it may be found that where plants like cabbage, pechay and mustard are especially susceptible to insect attacks the treatments certainly had a decided effect. It may be seen that the total yield for control plots of cabbage was 331 grams, whereas sprayed plots yielded 4532 grams and dusted plots 4329 grams. For pechay there is little advantage of the treated over the control. Control pechay yielded 3081 grams, sprayed pechay yielded 3478 grams, and dusted pechay yielded 3447 grams. For mustard, the control plants gave a yield of 2600 grams, sprayed

mustard yielded 2828 grams, and dusted mustard yielded 2924 grams. With such plants as lettuce, celery and onsoi which are not so subject to attack by insects as cabbage, pechay and mustard there was hardly any effect noticeable and there were cases where the control gave the better yield. This experiment was run two times and the results in both were similar.

Referring to table 1 for data on residual arsenic on sprayed cabbage (set 1, trial No. 1 of the experiment) the amount of 109.70 mgm. of arsenic per kgm. of dry material is found. This amount is greater than the lowest fatal dose for human beings, which according to Winslow (1919) is 97.20 mgm. of arsenic as As_2O_3. On a kilogram of fresh cabbage, 7.41 mgm. of residual arsenic were found. From the results of the experiment, excluding the 109.70 mgm. of arsenic found on sprayed cabbage, of no vegetable would enough be eaten by an individual to contain a dangerous dose of arsenic, even if expressed on dry vegetable basis. Calculated on fresh vegetable basis, even if the vegetables were not washed, there would not be enough arsenic on them to be harmful to consumers. It may be inferred from these data that no danger need be apprehended from dusting and spraying the vegetables used in this experiment under the conditions of the trials. A study of the table will reveal that plants harvested some time after treatment usually gave less residual arsenic than plants harvested within a shorter time, probably because of weather conditions. That is, if it is rainy the insecticides may be washed off and if it is dry and windy they may be blown off. The same result was found by Bourcart (1913) who stated that after twenty to twenty-four days, the poison had wholly disappeared from the surface of the plants.

It may also be seen from table 1 that with the exception of the second set for cabbage the averages of residual arsenic from the sprayed plants were more than from the dusted ones.

Determining their differences they were found significant in cabbage, set 2; lettuce, set 2; mustard, set 1; celery, sets 1 and 2; and onsoi, sets 1 and 2.

SUMMARY AND CONCLUSIONS

1. Two sets of experiments were carried with six different plants; namely, cabbage, pechay, mustard, lettuce, celery and onsoi, testing effect of dusting and spraying with insecticides on yield, amount of residual arsenic, and cost of insecticides and operation.

2. Under the conditions in which the experiments were carried, dusting cost more than spraying, because, (table 2) the amount of chemicals used for dusting was always more than for spraying.

3. The amount of arsenical together with the cost of operation is dependent on the frequency of application and nature of the vegetable.

4. With plants like cabbage, pechay and mustard which are susceptible to insect attacks the yield was affected by both dusting and spraying; with plants not so susceptible no difference in yield between the control and treated plants was observed.

5. The time between treatment of plant and harvesting affected the residual arsenic content. The shorter the time the greater the amount of residual arsenic.

6. The difference between residual arsenic in sprayed and dusted plants was found significant in celery and onsoi and in cabbage, set 2, lettuce, set 2, and mustard, set 1.

7. No amount of residual arsenic per kilogram of fresh material was found to exceed the lowest fatal dose for human beings.

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TABLE 1

Residual arsenic per kilogram of the vegetables

Cabbage, set 1

SAMPLE	DATE OF APPLICATION	DATE HARVESTED	MOISTURE	TOTAL RESIDUAL ARSENIC	
				Dry basis	Fresh basis
	1932	*1932*	*per cent*	*mgm.*	*mgm.*
1			92.36	55.26	4.22
2	Dusted		91.06	42.72	3.82
3	July 1, 14		89.88	38.18	3.86
4	Aug. 2, 15	Sept. 18	92.09	33.10	2.62
5	" 27		90.42	66.08	5.09
6	Sept. 5		90.79	57.77	5.67
7			91.49	35.07	2.98
Average				46.88	4.04
Probable error of average				±3.287	
1			93.25	109.70	7.41
2	Sprayed		92.79	49.90	3.60
3	July 1, 14		93.41	42.22	2.78
4	Aug. 2, 15	Sept. 18	94.09	39.96	2.36
5	" 27		92.30	47.76	3.68
6	Sept. 5		92.08	58.34	4.62
7			91.20	45.41	4.00
Average				56.18	4.06
Probable error of average				±6.204	
Probable error of difference				9.30 ± 7.021 (Insignificant)	

Cabbage, set 2

SAMPLE	DATE OF APPLICATION	DATE HARVESTED	MOISTURE	TOTAL RESIDUAL ARSENIC	
				Dry basis	Fresh basis
	1932	*1932*	*per cent*	*mgm.*	*mgm.*
1			94.98	10.86	0.55
2	Dusted	Dec. 26	94.51	6.61	0.36
3	Nov. 25		93.71	7.22	0.45
4	Dec. 1, 19		94.59	6.44	0.35
5			92.84	5.83	0.42
Average				7.39	0.43
Probable error of average				±0.6035	
1	Sprayed		94.92	1.78	0.09
2	Nov. 25	Dec. 26	95.31	2.01	0.09
3	Dec. 1, 19		93.12	0.39	0.03
4			94.71	1.75	0.09
5			93.70	1.46	0.09
Average				1.48	0.08
Probable error of average				±0.2232	
Probable error of difference				5.91 ± 0.6427 (Significant)	

TABLE 1 (Continued)

Pechay, set 1

SAMPLE	DATE OF APPLICATION	DATE HARVESTED	MOISTURE	TOTAL RESIDUAL ARSENIC	
				Dry basis	Fresh basis
	1932	*1932*	*per cent*	*mgm.*	*mgm.*
1	Dusted		91.82	11.77	0.96
2	Nov. 10, 18	Nov. 23	91.44	9.24	0.79
3			92.70	15.60	1.14
4			91.32	20.32	1.76
5			91.18	10.38	0.92
6			89.76	14.30	1.46
7			91.02	14.77	1.33
8			90.18	18.67	1.83
9			89.35	19.58	2.09
10			90.15	21.98	2.17
Average				15.66	1.45
Probable error of average				±0.9332	
1	Sprayed		92.49	9.26	0.70
2	Nov. 10, 18	Nov. 23	91.31	13.81	1.20
3			92.43	19.98	1.51
4			89.04	11.98	1.31
5			91.74	12.10	1.00
6			90.17	19.17	1.94
7			92.35	19.01	1.45
8			91.05	20.62	1.85
9			91.18	22.80	2.01
10			89.96	20.94	2.10
Average				16.97	1.51
Probable error of average				±1.003	
Probable error of difference				1.31 ± 1.368 (Insignificant)	

Pechay, set 2

SAMPLE	DATE OF APPLICATION	DATE HARVESTED	MOISTURE	TOTAL RESIDUAL ARSENIC	
				Dry basis	Fresh basis
	1932	*1933*	*per cent*	*mgm.*	*mgm.*
1	Dusted			Trace [a]	
2	Dec. 21, 28	Jan. 22		Trace [a]	
3				Trace [a]	
4				None	
5				None	
1	Sprayed		91.29	0.13	0.01
2	Dec. 21, 28	Jan. 22		Trace [a]	
3				Trace [a]	
4				Trace [a]	
5				Trace [a]	
Average				0.13	0.01

[a] Trace not included in average.

TABLE 1 (Continued)

Lettuce, set 1

SAMPLE	DATE OF APPLICATION	DATE HARVESTED	MOISTURE	TOTAL RESIDUAL ARSENIC	
				Dry basis	Fresh basis
	1932	*1932*	*per cent*	*mgm.*	*mgm.*
1	Dusted		92.63	3.27	0.24
2	Sept. 26	Oct. 7	92.82	3.62	0.26
3			93.30	2.92	0.20
4			93.40	2.99	0.20
5			93.33	2.49	0.17
6			93.44	3.10	0.20
7			93.38	2.65	0.18
8			92.65	1.74	0.13
9			93.03	2.30	0.16
10			92.65	3.81	0.28
Average				2.89	0.20
Probable error of average				±0.1322	
1	Sprayed		92.76	2.46	0.17
2	Sept. 26	Oct. 7	92.98	4.71	0.34
3			92.80	3.85	0.29
4			92.39	3.17	0.24
5			93.11	2.24	0.15
6			91.70	2.37	0.20
7			92.65	2.96	0.22
8			93.04	2.99	0.21
9			92.50	3.94	0.30
10			92.07	Trace [a]	
Average				3.19	0.24
Probable error of average				±0.1869	
Probable error of difference				0.30 ± 0.2289 (Insignificant)	

[a] Trace not included in average.

Lettuce, set 2

SAMPLE	DATE OF APPLICATION	DATE HARVESTED	MOISTURE	TOTAL RESIDUAL ARSENIC	
				Dry basis	Fresh basis
	1932	*1932*	*per cent*	*mgm.*	*mgm.*
1	Dusted		92.88	29.12	2.07
2	Dec. 1	Dec. 7	93.07	15.37	1.06
3			93.61	16.75	1.07
4			92.25	25.99	2.01
5			92.60	20.71	1.53
Average				21.59	1.55
Probable error of average				±1.777	
1	Sprayed		92.49	38.80	2.91
2	Dec. 1	Dec. 7	92.77	36.68	2.65
3			92.65	35.93	2.64
4			92.02	40.20	3.21
5			93.50	39.39	2.56
Average				38.20	2.79
Probable error of average				±0.5488	
Probable error of difference				16.61 ± 1.860 (Significant)	

TABLE 1 (Continued)

Mustard, set 1

SAMPLE	DATE OF APPLICATION	DATE HARVESTED	MOISTURE	TOTAL RESIDUAL ARSENIC	
				Dry basis	Fresh basis
	1932	*1932*	*per cent*	*mgm.*	*mgm.*
1	Dusted		89.99	13.82	1.38
2	Nov. 25	Dec. 14	84.37	11.76	1.84
3	Dec. 1		88.51	5.04	0.58
4			87.97	10.99	1.32
5			86.24	6.10	0.84
6			85.02	21.25	3.18
Average				11.49	1.52
Probable error of average				±1.613	
1	Sprayed		84.96	40.32	6.06
2	Nov. 25	Dec. 14	82.55	36.45	6.36
3	Dec. 1		82.94	39.91	6.81
4			83.35	25.43	4.23
5			86.60	42.97	5.76
6			85.86	37.33	5.28
Average				37.07	5.75
Probable error of average				±1.695	
Probable error of difference				25.58 ± 2.34	(Significant)

Mustard, set 2

SAMPLE	DATE OF APPLICATION	DATE HARVESTED	MOISTURE	TOTAL RESIDUAL ARSENIC	
				Dry basis	Fresh basis
	1932	*1933*	*per cent*	*mgm.*	*mgm.*
1	Dusted		90.85	14.09	1.29
2	Dec. 21, 28	Jan. 15	89.53	3.32	0.35
3			91.00	18.05	1.64
4			90.12	3.31	0.33
5			90.89	3.05	0.29
Average				8.36	0.78
Probable error of average				±2.164	
1	Sprayed		90.20	4.07	0.40
2	Dec. 21, 28	Jan. 15	90.82	4.49	0.41
3			89.95	20.88	2.10
4			88.45	3.44	0.40
5			89.61	18.24	1.90
Average				10.22	1.04
Probable error of average				±2.589	
Probable error of difference				1.86 ± 3.341	(Insignificant)

TABLE 1 (Continued)

Celery, set 1

SAMPLE	DATE OF APPLICATION	DATE HARVESTED	MOISTURE	TOTAL RESIDUAL ARSENIC	
				Dry basis	Fresh basis
	1932	*1932*	*per cent*	*mgm.*	*mgm.*
1	Dusted		86.24	3.05	0.42
2	Sept. 24	Oct. 16	86.68	3.61	0.48
3			86.23	2.76	0.38
4			86.70	2.99	0.40
5			86.30	2.88	0.39
Average				3.06	0.41
Probable error of average				±0.09774	
1	Sprayed		86.34	4.13	0.56
2	Sept. 24	Oct. 16	86.92	4.05	0.53
3			86.14	3.55	0.49
4			86.00	3.62	0.51
5			86.30	3.49	0.48
Average				3.77	0.51
Probable error of average				±0.09049	
Probable error of difference				0.71 ± 0.1332 (Significant)	

Celery, set 2

SAMPLE	DATE OF APPLICATION	DATE HARVESTED	MOISTURE	TOTAL RESIDUAL ARSENIC	
				Dry basis	Fresh basis
	1932	*1933*	*per cent*	*mgm.*	*mgm.*
1	Dusted		86.25	3.17	0.44
2	Dec. 19	Jan. 8	87.44	Trace [a]	
3			86.92	4.15	0.54
4			86.82	5.97	0.79
5			85.46	3.07	0.42
Average				4.09	0.55
Probable error of average				±0.4533	
1	Sprayed		87.00	15.96	2.07
2	Dec. 19	Jan. 8	86.12	12.43	1.73
3			86.91	18.39	2.41
4			86.78	21.04	2.78
5			87.00	13.60	1.77
Average				16.28	2.15
Probable error of average				±1.069	
Probable error of difference				12.19 ± 1.161 (Significant)	

[a] Trace is not included in average.

TABLE 1 (Continued)

Onsoi, set 1

SAMPLE	DATE OF APPLICATION	DATE HARVESTED	MOISTURE	TOTAL RESIDUAL ARSENIC: Dry basis	TOTAL RESIDUAL ARSENIC: Fresh basis
	1932	*1932*	*per cent*	*mgm.*	*mgm.*
1	Dusted		86.28	3.41	0.47
2	Oct. 7	Oct. 23	86.12	3.47	0.48
3			86.00	2.61	0.37
4			86.63	3.77	0.50
5			86.14	2.60	0.36
Average				3.17	0.44
Probable error of average				±0.1611	
1	Sprayed		86.19	4.19	0.58
2	Oct. 7	Oct. 23	86.15	3.97	0.55
3			86.29	3.77	0.52
4			86.22	3.42	0.47
5			86.13	3.90	0.54
Average				3.85	0.53
Probable error of average				±0.08532	
Probable error of difference				0.68 ± 0.1822 (Significant)	

Onsoi, set 2

SAMPLE	DATE OF APPLICATION	DATE HARVESTED	MOISTURE	TOTAL RESIDUAL ARSENIC: Dry basis	TOTAL RESIDUAL ARSENIC: Fresh basis
	1932	*1932*	*per cent*	*mgm.*	*mgm.*
1	Dusted		86.16	3.67	0.51
2	Dec. 19	Dec. 27	86.39	4.33	0.59
3			86.14	7.40	1.02
4			84.44	2.83	0.44
5			87.48	3.77	0.47
Average				4.40	0.61
Probable error of average				±0.5309	
	1932	*1932*	*per cent*	*mgm.*	*mgm.*
1	Sprayed		89.00	20.33	2.24
2	Dec. 19	Dec. 27	88.51	25.42	2.59
3			84.47	21.28	3.30
4			84.39	21.11	3.30
5			83.46	18.76	3.20
Average				21.38	2.93
Probable error of average				±0.7456	
Probable error of difference				16.98 ± 0.9154 (Significant)	

TABLE 2

Showing the amount and cost of operations

VEGETABLE	TREATMENT	PLANTS	FREQUENCY	TIME REQUIRED	TOTAL AMOUNT OF INSECTICIDES USED	AMOUNT OF MATERIAL USED: $PbHAsO_4$	AMOUNT OF MATERIAL USED: CaO	AMOUNT OF MATERIAL USED: H_2O	COST OF MATERIAL AND LABOR: $PbHAsO_4$	COST OF MATERIAL AND LABOR: CaO	COST OF MATERIAL AND LABOR: H_2O	TOTAL	COST OF OPERATION PER 100 PLANTS
		number		*minutes*		*grams*	*grams*	*cc.*	*pesos*	*pesos*	*pesos*	*pesos*	*pesos*
Cabbage set 1	Dusted	18	6	51	42.7 grams	7.10	35.50		0.007	0.106	0.082	0.20	1.10
	Sprayed	18	6	55	1392 cc.	4.18	1.39	1392	0.004	0.004	0.188	0.10	0.55
Cabbage set 2	Dusted	17	3	26	20.8 grams	3.46	17.3		0.003	0.052	0.042	0.10	0.59
	Sprayed	17	3	24	615 cc.	1.85	0.62	615	0.002	0.002	0.038	0.04	0.24
Pechay set 1	Dusted	38	2	26	17.2 grams	2.86	14.3		0.003	0.043	0.042	0.09	0.24
	Sprayed	38	2	32	460 cc.	1.38	0.46	460	0.001	0.001	0.051	0.05	0.13
Pechay set 2	Dusted	32	2	18	36.0 grams	6.00	30.0		0.006	0.09	0.129	0.13	0.40
	Sprayed	32	2	25	600 cc.	1.80	0.60	600	0.002	0.002	0.040	0.04	0.13
Mustard set 1	Dusted	40	2	32	26.8 grams	4.46	22.3		0.004	0.067	0.051	0.12	0.30
	Sprayed	40	2	34	731.7 cc.	2.20	0.73	731.7	0.002	0.002	0.054	0.06	0.15
Mustard set 2	Dusted	34	2	19	32.8 grams	5.46	27.30		0.005	0.082	0.030	0.12	0.35
	Sprayed	34	2	25	600 cc.	1.80	0.60	600	0.002	0.002	0.040	0.04	0.12
Lettuce set 1	Dusted	35	1	6	4.3 grams	0.72	3.60		0.0007	0.011	0.010	0.02	0.06
	Sprayed	35	1	7	130 cc.	0.39	0.13	130	0.0004		0.011	0.01	0.03
Lettuce set 2	Dusted	50	1	8	10.4 grams	1.73	8.65		0.002	0.026	0.013	0.04	0.08
	Sprayed	50	1	10	260 cc.	0.78	0.26	260	0.0008	0.001	0.016	0.02	0.04
Celery set 1	Dusted	60	1	11	13.0 grams	2.16	10.80		0.002	0.032	0.018	0.05	0.08
	Sprayed	60	1	14	325 cc.	0.98	0.33	325	0.001	0.003	0.022	0.03	0.05
Celery set 2	Dusted	75	1	12	15.0 grams	2.50	12.50		0.003	0.038	0.019	0.06	0.08
	Sprayed	75	1	14	330 cc.	0.99	0.33	330	0.001	0.001	0.022	0.02	0.03
Onsoi set 1	Dusted	100	1	10	12.5 grams	2.08	10.40		0.002	0.031	0.016	0.05	0.05
	Sprayed	100	1	13	390 cc.	1.18	0.39	390	0.001	0.001	0.021	0.02	0.02
Onsoi set 2	Dusted	120	1	12	13.0 grams	2.16	10.80		0.002	0.032	0.019	0.05	0.04
	Sprayed	120	1	16	400 cc.	1.20	0.40	400	0.001	0.001	0.026	0.03	0.03

TABLE 3

Showing the difference in yield of the treated and untreated plants

VEGETABLE	TREATMENT	SET 1		SET 2	
		Plants	Weight	Plants	Weight
		number	*grams*	*number*	*grams*
Cabbage	Dusted	18	4329	17	5602
	Sprayed	18	4532	17	6823
	Control	18	331	17	3309
Pechay	Dusted	38	3447	32	8412
	Sprayed	38	3478	32	8500
	Control	38	3081	32	8098
Mustard	Dusted	40	2924	34	5009
	Sprayed	40	2898	34	5271
	Control	40	2600	34	4897
Lettuce	Dusted	35	716	50	1868
	Sprayed	35	699	50	1893
	Control	35	703	50	1865
Celery	Dusted	60	722	75	1301
	Sprayed	60	719	75	1106
	Control	60	739	75	1220
Onsoi	Dusted	100	1098	120	1756
	Sprayed	100	1100	120	1738
	Control	100	1120	120	1780

NOTE: ON BANANA[1]

As an instance of neighborly exchange of scientific knowledge and products the following is of interest.

Under date of June 22, 1933 Dr. H. Wenholz, Director of Plant Breeding in the Department of Agriculture of the Commonwealth of Australia wrote Doctor Mendiola, Head of the Department of Agronomy in this College, telling him they were undertaking work in banana improvement. Their immediate objects were to obtain varieties resistant to bunchy-top and Panama diseases and also able to withstand strong winds. "Since the Philippines is a country which is very rich in species and varieties of Musa, I have thought that it would be possible for us to grow a number of seedlings from introduced seed amongst which we may obtain the varieties we are seeking."

Doctor Wenholz further asked Doctor Mendiola for advice as to the best lines on which to proceed, and also for some seed for raising banana seedling plants. Doctor Wenholz also wanted to know whether we had in this College any records of any varieties or species of Musa which are resistant to Bunchy-top.

Replying to Doctor Wenholz' letter, Doctor Mendiola wrote on July 26, 1933 as follows:

Dear Doctor Wenholz:

Referring to your letter of June 22nd just received, I would like to say that I do not know of any banana variety now grown in the Philippines which has been affected by the bunchy-top disease of our abacá. It is possible that your bunchy-top disease of banana is different from that of our abacá. I am enclosing a memorandum, prepared by our plant pathologist, which might interest you.

I am now gathering seed of some of our bananas and plantains and will send them to you as soon as possible. I would say, however, that the varieties of our banana from which seed may be gathered are far from being the commercial and the table kinds and that plants raised in New South Wales from our seed were reported by Prof. Goddard of New South Wales to have developed their bunchy-top.

Our banana that approached the export kind is the Buñgulan which is resistant to Panama disease. This variety, however, is seedless. If you care I could send you some corms by mail.

[1] General contribution from the College of Agriculture No. 357.

The memorandum prepared by Dr. G. O. Ocfemia, plant pathologist and referred to in the above letter follows:

Since 1925, when the undersigned began work on the bunchy-top of abacá, or Manila hemp (*Musa textilis* Née) he has never seen a case of banana infected with bunchy-top. Even bananas planted between hills of abacá infected with bunchy-top have not been attacked by the disease. In an article by the writer published in *American Journal* of Botany, Vol. 17, p. 2, 1930 it was stated that:

'Although abacá is very seriously infected by bunchy-top in Cavite and Laguna provinces the writer has not seen the disease on Philippine varieties of banana, *Musa sapientum*, and plantain, *Musa paradisiaca*, in the field.'

In the second paper of the bunchy-top of abacá series, now in preparation, the undersigned will describe experiments on transmission of the abacá bunchy-top to Philippine bananas since 1928, and discuss the probable relation of the banana bunchy-top virus in Australia to the abacá bunchy-top virus in the Philippine Islands.

In regard to the Philippine commercial varieties of bananas resistant to the Panama disease the following: Saba (*Musa sapientum* L. var. compressa Teodoro); Ternate, or Gloria (*M. sapientum* var. *ternatensis* Teodoro); Buñgulan (*M. sapientum* var. *suaveolens* Teodoro); and Lacatan (*M. sapientum* var. *lacatan* Teodoro) are highly resistant to this malady.

M. R. Monsalud
Of the Department of Agronomy

In the Sunrise Islands of Japan, Yusuke Tsurumi, a wise Japanese leader, was showing an American visitor through his picturesque garden.

"Here," he said, "fifty years ago my father planted a tree. Last week I cut down the tree. It had given shade, comfort, and nut products for sustenance these many years and to all our family it is a grateful memory. I hesitated to cut it down and only did so when I had satisfied myself"—he paused a moment. "Look at the vista." The guest looked, and before his eyes a volume of beauty, its pages splashed with color, with vine and shrub flecked with shadow and the gleam of sunshine, and then as far as eye could see, as the pages turned, dancing waves of the open sea, waves that invited to larger adventuresomeness.

"I only cut down the tree," said the leader of the youth of Japan, "when I found what a vista would be opened thereby."

President Williams, *University of Missouri*
What the Colleges are doing, May, 1933.

CURRENT NOTES

Directions for packing Bombay mangoes for export.

Fruit for export should be fully developed and reaped by stem cutting, leave about ¼ inch stem on the fruit.

Wipe dry and discard any with the slightest bruise and wrap with fine tissue paper.

Use flat crates about 4 inches deep and containing only *one* layer of fruit. (Something similar to the tomato crates). The crates should if possible be lined with wood wool.

The crates should hold only one or two or at most three dozens each. If necessary, two or three small crates can be tied together for shipment.

The Journal of the Jamaica Agricultural Society, April, 1933.

Hay made by passing hot air through grass in a new apparatus is said to have three times the protein content of the naturally dried article. It is thus three times as good for feeding live-stock.

The New Zealand Dairyman, February 20, 1933.

More than 150 delegates, representing 22 countries, are arranging to assemble in London as we go to press, for the three-days' centenary celebrations of the Entomological Society of London.

Among its many claims to distinction the Society can point to Charles Darwin as a former fellow. It can trace its ancestry back to 1745, and is the oldest society in the world devoted solely to insects. It is the father of economic entomology, a science which has achieved savings in agriculture valued at millions of pounds.

The pioneering connection of the Society is well brought out in a finely produced historical volume which has been published by the Society in connection with this week's celebrations.

Of special interest in the Society's history is clear proof provided that its members were the first to recognize the practical importance of their subject. In June, 1834, the Society's first prize essay was instituted, the subject being the turnip fly, which was then a serious pest.

Tropical Life, May, 1933.

"Less than twenty years ago," says Sir Frederick Keeble, "all the nitrogen which occurs in the earth and in the bodies of plants and animals was due to one natural agency. There are in the soil, widespread in all fertile earth, invisible but innumerable bacteria. They include the nitrogen-fixing bacteria; that is to say, bacteria which have the power to make the free nitrogen of the atmosphere enter into combination with other elements. They and they alone bring the nitrogen into that fruitful combination in which it can serve as food for plants and animals.

"But within the span of twenty years man has wrought a revolution more pregnant for the welfare of mankind than any other he has ever made. He can now supplement and surpass the work of the nitrogen-fixing bacteria; he can draw upon the vast supplies of the free elemental nitrogen which exists in the atmosphere, and, compelling the nitrogen to enter into union with oxygen and other elements, he can provide the essential nitrogenous food which the world, far more numerous and far more flourishing than it is at present, would require."

The Planter (F. M. S.), June, 1933.

A sample manurial trial with ginger carried out on four randomised blocks at Siyambalagoda in the Yatinuwara district, showed that definitely significant yield increases are obtained by manuring with sulphate of potash and a complete mixture. The average increase was nearly 80 per cent over the control in the case of the latter and nearly 40 per cent with the former. These increases are statistically significant, the probability being over 20 to 1 that the sulphate of potash and over 100 to 1 that the complete mixture are responsible for the increased yields.

The Tropical Agriculturist (Ceylon), May, 1933.

Mix equal quantities of milk and petrol; bottle and shake well. Keeps kid shoes lovely and white.

Live Stock Bulletin, April 1, 1933.

Dr. Ryan, Minister for Agriculture, received a deputation from the Irish Dairy Shorthorn Breeders' Society at Leinster House last week, and discussed with them the outlines of a national scheme for a "Drink More Milk" campaign which was prepared by the Society.

Mr. P. J. Halliden, Secretary, in outlining the scheme, said while the Irish were probably the largest butter-eaters in the world, they were very poor milk-drinkers compared with U. S. A., Sweden, Switzerland, etc.

He was afraid that the physique of the children was suffering seriously because milk was not more extensively used in their diet, and in this matter parents had a big responsibility. He promised to assist the campaign in every possible way and to go into the matter at once, with the object of getting a grant from the Ministry of Finance for the purpose.

The Farmers' Gazette (Ireland), May 13, 1933.

COLLEGE AND ALUMNI NOTES

Dr. Rui Feng, Director of Agriculture and Forestry of Kwantung Province and Dean of College of Agriculture, Lingnan University, Canton, China accompanied by Generals Weng Shat-lang and Wei Swei-shing and Colonel Lui Ting-eng who are interested in improving breeds of Chinese cavalry horses and Mr. Sheet Bo-kwan industrial chemist spent two days on the Campus in August guests of the College and School of Forestry.

Dr. T. Shibuya of Taihoku Imperial University, Government Central Research Institute, Formosa, Japan, was a recent visitor to the College. He is interested in breeding and selection of important crops. He was much impressed with the various varietal hybrids of some introduced cotton varieties produced by the Plant Breeding Staff of the Department of Agronomy.

Dr. Robert L. Pendleton has received from soil scientists in different parts of the world, warm words of appreciation of his translation from the Dutch of Dr. E. C. Jul. Mohr's book on *Tropical soil-forming processes and the development of tropical soils.* This translation was issued by this College in mimeographed form in 1930, and early this year was published by the National Geological Survey of China.

Mr. Leopoldo P. Abes, '27, sugar agronomist of the Nueva Ecija Sugar Mills, Inc., donated to the Department of Agronomy an implement locally known in Nueva Ecija as *tapil.* It is commonly used

for planting cane points in Nueva Ecija. With the use of the tapil a planter, according to Mr. Abes, can plant 10,000 points a day, earning a wage of 60 centavos.

The eighty-fourth regular scientific meeting of the Los Baños Biological Club was held in the Lecture Hall of the Poultry Building, College of Agriculture, on Thursday, July 20, 1933, at 7:30 p. m.

The following papers were read and discussed:

"Harmful effects of rice straw when added to soil in pots upon young rice and maize plants."

By Dr. R. B. Espino, and Mr. F. T. Pantaleon.
(Paper read by Doctor Espino.)

"A proposed method of determining the area of a circular segment: Its application in the computation of the volume of slabs from cylindrical logs."

By Mr. Justino Seguerra.

"Effect of various methods of storing corn on the degree of damage due to weevils."

By Dr. L. B. Uichanco, and Mr. S. R. Capco.
(Paper read by Doctor Uichanco.)

The following paragraph is quoted from an editorial in *Peking and Tientsin Times* of May 25, 1933 on agricultural improvement in China. Dr. Pendleton is head, Soils Department in this College.

A great deal is now being done in unobtrusive ways to prepare for this immense task. The work of the China International Famine Relief Commission is familiar to everybody, though not in all its provincial ramifications perhaps. The Agricultural College of Nanking University has been a powerful and invaluable worker in the same field. The Geological Survey has been conducting a Soil Survey in the North-West, under the direction of Mr. Robert L. Pendleton—an experienced scientist—and a group of Chinese colleagues, the printed reports of which, with illustrations and minute detail, are of great value. These enterprises constitute the beginning of what may well prove to be the most useful constructive phase of China's present activities, for they can be pursued through all the vicissitudes of higher politics and other grave troubles by local and voluntary effort and enthusiasm.

The Bureau of Plant Industry purchased from the Department of Agronomy, through Mr. Paul L. Villyar, B. Agr. '17, an employee of the bureau, 100 meters of cassava cuttings of each of the varieties, Aipin Mangi, Aipin Valenca, and Mandioca Basiorao. These cuttings were shipped to the Experiment Station of the Bureau of Plant Industry at Alabang, Rizal.

At the meeting of the U. P. Chapter of the Phi Kappa Phi society on June 20, Dr. N. B. Mendiola was elected corresponding secretary. The new members from the College elected at the meeting were: Dr. L. B. Uichanco, Dr. F. O. Santos, Dr. G. O. Ocfemia, Dr. F. M. Fronda, and Mr. Dennis Molintas, B.S.A. '34. The other members of the society from the College are: Dean B. M. Gonzalez (first president), Dr. Valente Villegas, Dr. A. L. Teodoro, and Dr. F. M. Sacay.

Messrs. Dennis Molintas and Porfirio R. Manacop of the Class of 1934 were elected associate members in the Society for the Advancement of Research, a scientific and honorary society, in the meeting of the society held on July 6, 1933.

Mr. Nicomedes C. Flores B.S.A. '27 was recently appointed principal of Odioñgan Rural High School, Romblon, succeeding Mr. Florencio Bagui, B.Agr. '13, retired.

Mr. Fernando D. Luistro, B.Agr. '15, in charge of the Maridagao Rubber Experiment Station of the Bureau of Plant Industry at Pikit, Cotaboto, was a Campus visitor on August 8, 1933. Mr. Luistro had not seen the College for about thirteen years. He marvelled greatly at the changes on the Campus. Mr. Luistro obtained seeds of Kawisari coffee from Doctor Mendiola.

Mr. Dominador D. Clemente, '33, passed the teacher's examination given by the Bureau of Civil Service in Laoag, Ilocos Norte, on April 7-8, 1933. This qualifies Mr. Clemente to teach in any of the academic high schools in the Islands. He is at present the principal teacher of the Maquiling School, private elementary school conducted under the supervision of the Department of Agricultural Education for the children of the faculty and employees of the College of Agriculture and School of Forestry.

Mr. Olimpio Fontanilla, '33, formerly working in The Economic Garden, Bureau of Plant Industry, Los Baños, was recently placed in charge of the provincial nursery of Negros at Bacolod, Occidental Negros.

Mr. Conrado B. Uichanco, '33, is enrolled as freshman in the College of Law, University of the Philippines.

At a meeting of the Mimics held in Molawin Hall Club Room on August 3, 1933 the following officers were elected:

Raoul Arana	President
Andres Caranto	Vice-President
Federico Reyes	Secretary
Venancio Duarte	Treasurer
Felix de Leon Flores	Business Manager
Victorio Antonio	Advertising Manager
Gabriel Flores	Stage Manager
Pedro Lorenzo	Property Custodian

In addition to officers old members are:

Martin Rosell	Flaviano Olivares
Primo Castro	Celestino Quilang
Romulo Gines	Felix Remigio
Laureano Lucas	Abel Silva
Rasuman Macalandong	Constantin Valera

New members received are:

Antonio Ocampo
Romeo Espino
Francisco Gomez

Miss Anne Cole, of the Department of English is Director of the Mimics.

On July 11, the Associated Women Students (A. W. S.) of the College of Agriculture held their first meeting of the College Year in the club room in Molawin Hall.

As the members of the association are few in number this year, the Adviser decided to include the girls from the U. P. Rural High School. This makes the membership of the A. W. S. twenty-three.

The following officers were elected, for the first semester:

President	Felicidad Chan
Vice-President	Asucena Bigornia
Secretary	Elsa Roa
Treasurer	Lydia Arnaldo
Reporter	Leona E. Atienza

The adviser of the association is Mrs. Harriett Richards, instructor in English in the U. P. Rural High School.

IN MEMORIAM

MATEO D. JIMENES, B.Agr. '26; B.S.A. '28.
Teacher in Odioñgan Rural High School, Romblon 1929-1933.

Odioñgan, April 29, 1933.

INTERNATIONAL COÖPERATION IN AGRICULTURE [1]

It is inevitable that the Philippines in the development of scientific agriculture as well as in the development of the general field of science and education have as a whole been influenced by temperate regions. For three hundred years, Spain was the source of the cultural development of the Philippines, while during the last three decades the guidance has come largely from the United States. The inevitable result of trained teachers and scientific researchers from the temperate Occident combined with a paucity of local instructional material has been a real handicap in the growth of an indigenous scientific point of view. This has resulted in a limiting of the horizon and of the conception and development of new opportunities.

Because of this long and close connection with temperate regions, in agriculture we have failed to adequately tap and use the vast resources of scientific research and practical experience accumulated in other parts of the tropics. Java, Sumatra, Malaya, Ceylon, India, Indo-China and Taiwan all have much to contribute in the way of agriculture and scientific experience. Forestry in the Philippines is perhaps the one exception, for a strong policy of conservation and rational development of the forest resources has been provided here from the commencement of American sovereignty, and the income obtained from our vast forests has stimulated the development of tropical forestry to an extent unexcelled in the world.

The travels of the writer in China during the last two years, particularly in South China, which is subtropical and in many ways similar to the Philippines in general agriculture and forestry problems, has revealed the same tendency in that country. South China, as well as the rest of that country, has been looking to the temperate Occident for help and leadership in agriculture and forestry. From the United States and from France Chinese students have returned to lead in agricultural work, while Germany has been a leading inspiration for forestry. South China has not only inadequately realized the great advantages of tapping our limited stores of knowledge in the subtropical Philippines, but is apparently even

[1] General contribution from the College of Agriculture No. 362.

PHILIPPINE AGRICULTURIST, VOL. XXII, No. 6, NOVEMBER, 1933.

unaware that there are vast resources of scientific knowledge and experience which are to be had for the asking from elsewhere in the tropics.

An added reason for China's technical leadership looking to the temperate Occident is that government scientific institutions in China have been greatly handicapped by the political instability of the country. The burden of making and developing scientific contacts has thus fallen to a great extent upon private institutions and the encouragement and support of missionary institutions such as Lingnan University and Nanking University. These all have their bases in the temperate Occident.

An example of a less than the best possible development in South China, owing to a failure to obtain help from the tropics has been the efforts at afforestation in Kwangtung according to European methods. Such methods for European regions are unexcelled, but are far from being the most suitable for humid oriental subtropical regions. The methods of afforestation developed right here in Los Baños in our Bureau of Forestry for the afforestation of cogon lands by the use of ipilipil and similar trees is much superior to anything thus far used in South China, or probably elsewhere in the world.

Recently, however, among Kwangtung authorities there has been an awakening to the possibilities and advantages of looking for help from the tropical regions rather than exclusively from temperate countries. Last June, three undergraduates, Ho Chak Man, Ho Pak Ping, and Wong Tit from the College of Agriculture of Lingnan University were sent to our College for a year for special work in animal husbandry. It is interesting to hear their comments upon and enthusiastic approval of the spirit they find here and the dignity in which labor is held on our Campus. They contrast this with school spirit in China where students would not think of feeding pigs in a Chinese agricultural college.

A more recent evidence of the realization of the advantages of international study and coöperation in agriculture and forestry is the visit of Dr. Rui Feng and his party from Kwangtung and Kwangsi provinces. Doctor Feng is Director of Agriculture and Forestry of Kwangtung Province and at the same time Dean of the College of Agriculture, Lingnan University. Accompanying Doctor Feng were five other men. Of these, Generals Weng Shat-lang and Wei Swei-shing and Colonel Lui Ting-eng were particularly interested in horses, because of the need of developing a better breed of horses for the cavalry in South China. Mr. Sheet Bo-Kwan, a commercial and in-

dustrial chemist, was particularly assigned to study the problems of sugar cane milling and plantation white sugar production with a view of developing these in Kwangtung. Doctor Feng and General Wei were also interested in the afforestation work because of the vast extent of lands in South China that might well be producing trees for fuel and timber. Mr. W. K. Smith was the financial adviser to the group. The party as a whole were also interested in the improved strains of cattle, pigs and poultry that have been developed here. They realize the great advantage of the disease-resistance of the local Berkjala strains that have been developed for our subtropical conditions.

It is unnecessary to describe in detail the itinerary of this party in the Islands. They visited many of the government departments and cattle breeding farms on the island of Luzon and a number of private establishments for agricultural and commercial activities. Dr. Victor Buencamino of the Bureau of Animal Industry acted as one of the leading representatives of the Philippine government in planning their itinerary and in entertaining them. It fell to the writer, because of his work in China, to represent the College of Agriculture.

The entire party, accompanied by Doctor Baladad, a graduate of our College of Veterinary Science who is now of the faculty of Lingnan University, and Mr. Theodore Nickelsen of Iloilo, arrived on our Campus on the morning of August 17. After meeting the Acting Dean, Dr. N. B. Mendiola, the party visited a number of the main College departments. The visitors were particularly interested in sugar cane breeding, poultry and animal husbandry. At noon, the faculty entertained the visitors at luncheon in Molawin Hall. Messrs. Smith, Sheet, Baladad and Nickelsen returned to Manila after the luncheon. Doctor Feng and the three others of the party that remained over-night visited the School of Forestry and the Maquiling National Park.

The visitors were given an idea of the nature and results of the ipilipil afforestation of cogon lands as carried out in the Paliparan tract above Los Baños. They then visited the Bureau of Plant Industry's Economic Gardens which occupy the old Camp Eldridge site at Los Baños. In the afternoon the party accompanied by Professor Curran and the writer was driven through the coconut regions to Pagsanjan and the Botocan Falls Power Plant. From Botocan, Doctor Feng and the three other members of his party returned direct to Manila.

That the interest of the visitors in improved plants and animals as verbally expressed was not mere idle words is evidenced by the fact that the party purchased from our College, from the Bureau of Forestry and from the Bureau of Plant Industry, and other organizations, large quantities of forest trees and seeds of various kinds, budded fruit trees such as avocados and mangoes, new varieties of sugar cane and a wide selection of poultry and live stock. They were disappointed that at the present time there are not available any Canton poultry nor Berkjala pigs, both breeds of which appealed to them very much. The collection of plants and animals purchased in the Philippines were taken to China by Doctor Baladad on the *S. S. City of Pittsburg* which left Manila on August 5.

In connection with the proposition of encouraging increased cane cultivation and the establishment of a small modern sugar central in Kwangtung, several of the party spent considerable time and effort in visiting sugar centrals and consulting sugar mill experts, including Professor King of our faculty. Then W. G. Hall, Vice-president of the Honolulu Iron Works, and Mr. Brown of the same corporation accompanied the party back to Kwangtung for a reconnaissance survey.

It is very much to be hoped that this successful exchange of visits of technical specialists is only the beginning of a much closer coöperation in agricultural and forestry research and demonstration work that will continue for years and which is certain to react to the great mutual benefit of both regions.

ROBERT L. PENDLETON
Of the Department of Soils

I have heard Mr. Hoover poke fun at the overworked methods of "efficiency" by telling the story of an efficiency engineer who was sent to revise a faraway industry.

The man arrived in a heavy snowstorm and was met by an Irishman driving a sled that was equipped with a buffalo robe. The efficiency expert climbed into the sled, and the Irishman started to wrap the robe around him with the hair outside.

"Oh, no," objected the engineer. "Don't you know that it is more impervious to wind, and therefore warmer, with the hair inside?"

The Irishman turned the robe and tucked it in, but when he mounted to his seat began to chuckle.

"What are you laughing at?" asked the efficiency expert.

"I was just thinking," replied the Irishman, "what a mistake that buffalo made."

Hoop and Horns, Arizona
Reprinted in, *What the Colleges Are Doing*

DISTRIBUTION OF MOSAIC AND FIJI DISEASES IN SUGAR CANE STALKS; EFFECTS OF THESE MALADIES ON THE GERMINATION OF THE EYES AND TRANSMISSION OF THE VIRUSES BY PIN PRICKS [1]

G. O. OCFEMIA, EVARISTO A. HURTADO AND
CRISPINIANO C. HERNANDEZ
Of the Department of Plant Pathology

WITH SIX TEXT FIGURES

In 1929, Stahl and Faris of the Tropical Plant Research Foundation in Cuba described the behavior of the new POJ canes (*Saccharum officinarum* L.) in relation to grass mosaic. These authors noted that when the highly resistant POJ canes are attacked by mosaic disease and the infected plants are planted the number of eyes that produce mosaiced stalks vary. They did not find stalks which produced mosaiced plants from all of the eyes as is the case with susceptible canes. From their observation, Stahl and Faris (1929) stated that in highly resistant POJ sugar cane varieties the mosaic is not distributed throughout the whole stalk as it is in susceptible canes.

An instance similar to this was reported by Ocfemia (1932) in which he found that some of the eyes of one stalk of a native variety of sugar cane, Linabnig, produced shoots that were free from mosaic symptoms. In this case, however, Ocfemia noted that although the plants were free from mosaic symptoms they contained the infective principle. This conclusion was arrived at when the apparently mosaic-free shoots were used as source of inoculum in transmission experiments to susceptible canes following the pin-prick method of Wilbrink (1929) and Sein (1930).

As it seems to be universally accepted that the infective material of virus diseases is present throughout the plant, although as a rule the roots may not be seriously affected, the present work was undertaken to determine the behavior towards mosaic and Fiji disease of the sugar cane varieties in common culture in the Philippines.

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[1] This paper is based on data used in the theses presented by the junior authors for graduation, 1933, with the degree of Bachelor of Science in Agriculture from the College of Agriculture Nos. 363 and 364; Experiment Station contribution No. 910.

Received for publication August 22, 1933.

THE MOSAIC AND THE FIJI DISEASES OF SUGAR CANE

Literature relating to cause and methods of transmission

Many papers have been published which deal with various phases of both mosaic and Fiji diseases of sugar cane. Only articles dealing with the cause of each of these two diseases are reviewed in this paper. The virus nature of the mosaic disease was shown by Brandes (1920, 1923) who found that the corn aphid (*Aphis maidis* Fitch.) disseminates the sugar cane mosaic in the field. The insect-transmission of mosaic of sugar cane reported by Brandes was confirmed by Wilbrink in Java, by Kunkel in Hawaii and by Bruner in Cuba (Johnston, 1924). Our students at the College of Agriculture at Los Baños have repeatedly obtained successful transmission of the mosaic disease of sugar cane with *Aphis maidis* as vector.

In 1919, Matz noted what appeared to him as an organism in the tissues of sugar cane attacked by mosaic, but later he showed that the plasmodium-like bodies were not consistently present in the mosaiced cane tissues. Kunkel was also reported by Johnston in 1924 as having found definite bodies of protozoan nature. The true character of these bodies, however, could not be ascertained. Cook (1926a,b) studied the effect of mosaic on the content of the cells and the photosynthesis of the sugar-cane mosaiced plant.

A method for mechanically transmitting sugar cane mosaic was reported by Wilbrink (1929) in Java and described in detail by Sein (1930) in Porto Rico. A new method for artificial transmission of sugar cane mosaic with the use of expressed juice of diseased plants was recently described by Matz (1933).

Tower (1919) reported failure to transmit sugar cane mosaic by crushing and rubbing mealy bugs from diseased canes on the developing buds and shoots of healthy plants. This author further reported that he was unable to infect sugar cane with mosaic by forcing crushed insects into punctures made in the buds and shoots.

In the Fiji disease, Lyon (1921) reported the presence of plasmodium-like bodies in the gall cells of the infected plants and suggested the name *Northiella sacchari* for these bodies. Reinking (1921a, b) at that time plant pathologist of the Experiment Station of the College of Agriculture at Los Baños, Laguna, Philippine Islands and Kunkel (1924a) in Hawaii also noted these intracellular bodies. McWhorter (1922) working also in the College of Agriculture at Los Baños concluded that the intracellular bodies in the gall cells of Fiji-infected canes are foreign organisms. This author regarded these

bodies, which he named and described as *Phytamoeba sacchari*, as of etiologic significance to the Fiji disease. Although the existence of Fiji disease was first reported in 1910 by Lyon (1921), from specimens and photographs sent to him in Hawaii by Mr. D. S. North of Australia, the nature and method of transmission of the disease were not definitely known for more than two decades.

In the October, 1932 issue of *The Philippine Agriculturist* and in the November, 1932 issue of *Sugar News* (Manila) appears our first record that successful transmission of the Fiji disease of sugar cane by *Perkinsiella vastatrix* Breddin was obtained by G. O. Ocfemia of the Department of Plant Pathology of the College of Agriculture at Los Baños, Laguna, Philippine Islands. [2] The detailed report of the experiments is in press in the *American Journal of Botany*. The paper by Mungomery and Bell (1933) of the Queensland Bureau of Sugar Experiment Stations, Australia corroborates our results at Los Baños that Fiji disease is transmitted by the sugar cane leaf hopper. According to Mungomery and Bell (1933, p. 20, 21) their last series of experiments which produced infection on February 4, March 6, and April 1, 1933, definitely establishes the fact that the Australian species of sugar cane leaf hopper, *Perkinsiella saccharicida* Kirk., is a vector of the Fiji disease in Queensland.

These authors further state that a field chemist at Nausori, Fiji who made continuous observations for about two years was much inclined to attribute the increase in the rate of transmission of Fiji disease to the increase in the number of *Perkinsiella vitiensis*. According to Mungomery and Bell (1933) this observation, together with the short report in the October, 1932 issue of *The Philippine Agriculturist* that Ocfemia had successfully transmitted Fiji disease with *Perkinsiella vastatrix*, and their own success in transmission with *Perkinsiella saccharicida* at Queensland would seem to indicate that the dissemination of the Fiji disease is not confined to a single species of the genus *Perkinsiella*.

In addition to the paper by Stahl and Faris (1929), however, very little has been done to determine whether or not the mosaic and Fiji diseases are distributed throughout the entire sugar cane plant.

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[2] The paper entitled "The transmission of the Fiji disease of sugar cane by an insect vector" was read by the senior author before the section meeting, Agriculture Veterinary and Forestry, of the Second Philippine Science Convention at Manila, Philippine Islands, February 16, 1933. In the evening of the same day the author read at the eighty-first meeting of the Los Baños Biological Club at the College of Agriculture a paper entitled "Evidence relating to the transmissibility of the Fiji disease of sugar cane by an insect vector".

The economic importance of the mosaic and Fiji diseases of sugar cane

The mosaic and Fiji diseases of sugar cane are two of the maladies of major importance to the sugar cane industry of the Philippine Islands. Lee (1923) reported that in certain districts in Negros the mosaic disease was causing 10 to 60 per cent of loss and the Fiji disease from 10⅔ to 25 per cent. Lee, formerly of the Philippine Sugar Association, in his annual report in 1929 stated that the loss

Fig. 1.—Part of the leaf of H-109 sugar cane attacked by the mosaic disease showing the mottling symptom. (All photographs, except figure 5, by the Photographic Division, Department of Soils, College of Agriculture.)

caused by mosaic disease is about 45 to 70 per cent in the tonnage and sugar yield per hectare in the native varieties of sugar cane and about 21 to 65 per cent in the introduced varieties.

Lyon (1921) reported that the Fiji disease was very serious in the Fiji Islands at one time. Reinking (1921a, b) stated that in extremely serious cases losses of 50 to 75 per cent of the crop were

not rare. Roxas (1926) noted an infection caused by Fiji of 2 to 75 per cent of the canes in the field. In June, 1926 there was a serious outbreak of Fiji disease on the ratoon crops in fields aggregating 300 hectares in Dayap, Calauan, Laguna. Estimates made by the Department of Plant Pathology of the College of Agriculture at Los Baños, from the badly infected areas ranging from one-third to

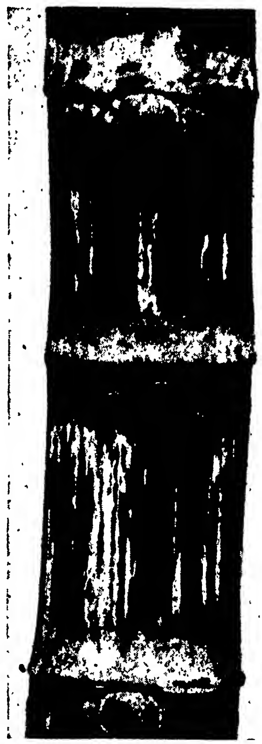

Fig. 2.—Portion of a stalk of sugar cane variety Badila attacked by the mosaic disease, showing the cankered areas on the rind.

one hectare patches showed that from 21.7 to 71.6 per cent of the canes were affected by Fiji disease and were very much stunted. (Ocfemia, 1926).

How the two diseases may be distinguished from each other

The mosaic disease. The distinguishing symptoms of the mosaic disease have been described by various authors. The disease may be

easily recognized by the mottling of the leaves with a lighter shade of green or yellowish green (fig. 1). The mottled areas are more or less elongated into streaks which are arranged with their long axes parallel with the veins of the leaves. The chlorotic streaks are broken and never form continuous stripes. The mottling may be

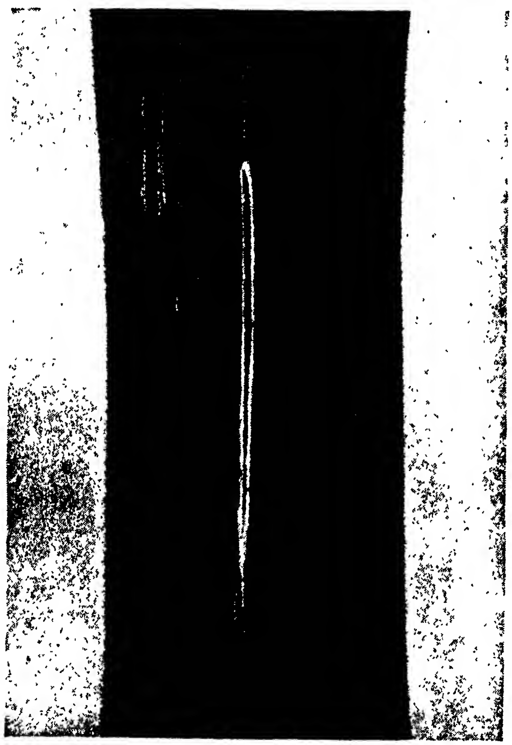

Fig. 3.—Portion of the base of the youngest expanded leaf of shoot 7c of POJ 2878 sugar cane used in experiment 4 of Fiji-disease transmission on October 4, 1932, photographed on February 5, 1933 to show in the advanced stage of the disease a gall 38 millimeters long and two millimeters wide on the back of the midrib.

distinct or indistinct depending upon the stage of the disease, age of the leaf, and the variety of cane attacked.

The severe infection of cane by mosaic in a field can be seen easily, even at a distance, on account of the light green color of the leaves of infected plants.

In some varieties of sugar cane, canker of the stalk is a distinguishing symptom (fig. 2). The canker of the stem corresponds very closely in shape and size to those of the mottled areas on the leaves.

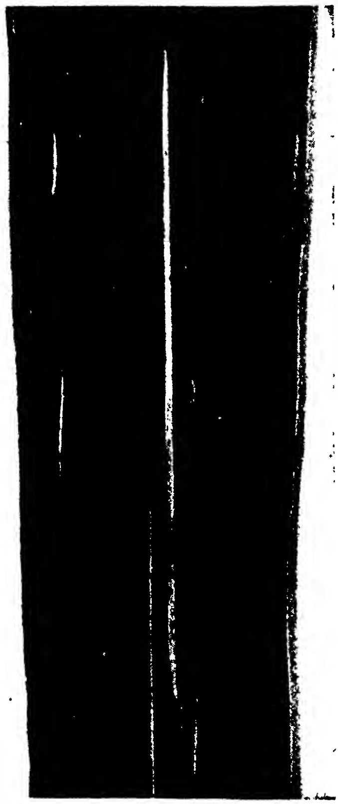

Fig. 4.—The lower portion of the leaf of shoot 3b of cane variety POJ 2878 used on October 4, 1932 in Fiji-disease transmission experiment 4 with *Perkinsiella vastatrix* Breddin showing in the advanced stage of the disease a gall 10 centimeters long on the back of the midrib. Note the shorter galls on the blade close to the left margin of the leaf. Photographed March 23, 1933.

The Fiji disease. The most characteristic and reliable symptom of Fiji disease is the appearance of elongated galls on the veins. These galls are easily seen on the nether surface of the leaves and

midribs and on the leaf-sheaths. In advanced cases of Fiji disease obtained from insect-transmission experiments, galls which are 38 (fig. 3) to 100 millimeters in length and one to one and one-half millimeters in width (fig. 4) may be found on the nether surface of the midribs. These large galls may also be found on the leaf sheaths of the infected canes. Later, these large galls rupture and become brown in color.

In very advanced stages of the Fiji disease, galls may not be produced. Instead, the diseased canes produce short or narrow more or less erect and stiff leaves which have a tendency to tear into strips. The leaves are darker green in color than those of healthy plants but the color is dull.

When the main shoot begins to produce short and malformed leaves the eyes may grow and send out leaves causing the canes to present a bushy or fan-like appearance. Tillers may also be produced in abundance. The leaves of the lateral shoots and tillers are also short and malformed like those of the central bud (fig. 5).

Sugar cane is susceptible to Fiji disease during its entire life. If plants are infected at emergence of the shoots no stalks are produced.

EXPERIMENTS TO DETERMINE THE DISTRIBUTION OF THE MOSAIC DISEASE AND FIJI DISEASE IN THE STALKS OF SUGAR CANE

On account of the economic importance of mosaic and Fiji diseases of sugar cane a knowledge of the distribution of these diseases in the infected stalks is of great importance. This knowledge will enable us to attribute the absence of mosaic or Fiji disease symptoms either (1) to some property of the protoplasm of the host which prevents the production of adverse effects and manifestation of characteristic symptoms, or (2) to absence of the virus in such shoots. At this point it seems pertinent to consider three of the terms used in connection with sugar cane mosaic. Stahl and Faris (1929) explain resistance to mosaic as the power of some canes to ward off infection. These authors explain immunity as the ability of the canes to ward off the disease completely. When sugar cane varieties readily become infected but are only slightly affected by the disease these canes are said to be susceptible but tolerant to the trouble. Stahl and Faris (1929) doubted whether they were dealing with tolerant canes in their work although they state that POJ 26 is reported as of this type.

Kunkel (1928) states that virus diseases are systemic, although conspicuous symptoms are produced only in the leaf and stem tissues. Not much seems to be known of the effect of virus diseases on the roots. Working on the mosaic of tobacco in 1914 Allard found that the roots contain virus. Other workers, notably Goldstein (1926), and Rosen (1926) found the virus in the roots of infected plants.

Fig. 5.—An advanced stage of the Fiji disease of sugar cane showing the short distorted or malformed leaves and the production of lateral shoots. (Photograph by the Bureau of Science, Manila.)

Kunkel (1928) further states that the grass mosaic causes lesions throughout the stalk tissues in some varieties of sugar cane and the Fiji disease produces galls throughout the infected stalks.

Materials and methods

Cane varieties used and their sources. Of the sugar cane varieties used in this work healthy, mosaic infected, and Fiji-disease in-

fected stalks were secured. The varieties used for determining the distribution of the mosaic and Fiji diseases in the stalks are presented in the following tabulation:

VARIETY NAMES	SOURCES	NUMBER OF STALKS USED		
		Healthy	Mosaiced	Fiji-infected
Luzon White	Vicinity of the College of Agriculture	15	15	15
Pampanga Red ..	Vicinity of the College of Agriculture	12	12	12
Mauritius 1900 ..	Department of Agronomy ..	12	12	12
POJ 2727	Calamba Sugar Estate and Department of Agronomy .	11	0	15
U×D 1	Calamba Sugar Estate	4	0	4
E.K. 28	Calamba Sugar Estate	2	0	2
Badila	Lemery and Nasugbu, Batangas	5	4	5
P.S.A. 14	Del Carmen, Pampanga	4	4	2
H-109	Calamba Sugar Estate	4	4	4
H-27	Calamba Sugar Estate	2	2	2
Q-409	Department of Agronomy ...	2	2	2
N.G. 24-B	Nasugbu, Batangas and Department of Agronomy ...	3	2	4
N.G. 24	Department of Agronomy ...	2	2	2
POJ 24	Nasugbu and Lemery, Batangas	4	0	4
POJ 2714........	Nasugbu and Lemery, Batangas	2	0	2
POJ 2878	Del Carmen, Pampanga	10	24	8

Generally, in each experiment, one healthy, one Fiji infected and one mosaiced cane stalk of each variety was used. However, there were instances when one healthy stalk of each variety was used as check for two or more Fiji-infected or mosaiced stalks of the same variety.

Preparation of the soil. Surface soil taken from the farm of the College of Agriculture was used in this work. The soil was sterilized by placing it on a pan of galvanized iron and heating it from one to two hours. It was stirred occasionally to expose as much as possible all portions of the soil to the surface of the heating pan and to prevent burning much of the organic matter of the soil. The sterilized soil was put in kerosene cans cut in halves and in pots for planting.

The soil was sterilized in order to kill fungi, bacteria or nematodes which might affect seriously the germination of the buds.

Treatment of the canes used. Mature healthy stalks as well as mosaic-infected and Fiji-diseased canes were secured from each variety. The method of securing canes in the field, the precautions observed in the handling of the canes and the preparation of one-node cuttings were as described by Ocfemia in the detailed report on insect-transmission of the Fiji disease. One-node cuttings were used in all of the experiments described in this paper because under conditions obtaining in the Philippines all results with the use of cuttings with more than one eye would be unreliable. In transmission studies the unreliability of the results increases when the cuttings are taken from different stalks.

The one-node cuttings were labeled properly using ordinary 6-inch garden labels, cutting them into two and sharpening one end and driving it into the upper end of the cuttings. The cuttings were planted in pots or in cans filled with sterilized soil one cutting to each pot or can. The same treatments were applied to the healthy, mosaic-infected and Fiji-disease infected canes.

In all the processes of preparing the cane points care was taken to prevent the contamination of the healthy with the diseased canes either by the hands and knife or through contact.

Observations: criteria of results. The appearance of symptoms of mosaic or Fiji disease on the young shoots and the nodes which produced them were recorded. The criteria used for determining the appearance of the early symptoms were as follows:

(1) *For grass mosaic.* Appearance of small, irregular, pale yellow patches, alternated with green on the first developed leaves.

(2) *For Fiji disease.* Appearance of one or more elongated vein swellings on the nether surface of the leaves.

In this work, buds which germinated but died soon after emergence without symptoms of either mosaic or Fiji disease, as the case might be, were, for convenience, called non-viable buds. If mottling was noted on the leaves the shoots were considered mosaiced. If galls were present they were considered Fiji infected shoots.

Results and discussion

Experimental. From the results it was noted that all of the shoots that came from the mosaic infected and Fiji infected stalks produced symptoms of the disease after emergence.[3] These results are in accord with the consensus of opinion that the infective principle in virus diseases is distributed throughout the whole diseased plant.

[3] The tables containing detailed data of germination studies by Evaristo A. Hurtado are in the files of the Department of Plant Pathology of the College of Agriculture.

Of the infected stalks of POJ cane varieties used in this work only one out of 24 stalks of POJ 2878, or four per cent, was found to produce shoots (three in number) that were apparently free from the disease, although they came from a mosaiced stalk (fig. 6). None of the Fiji-infected canes in any of the varieties tested exhibited this phenomenon.

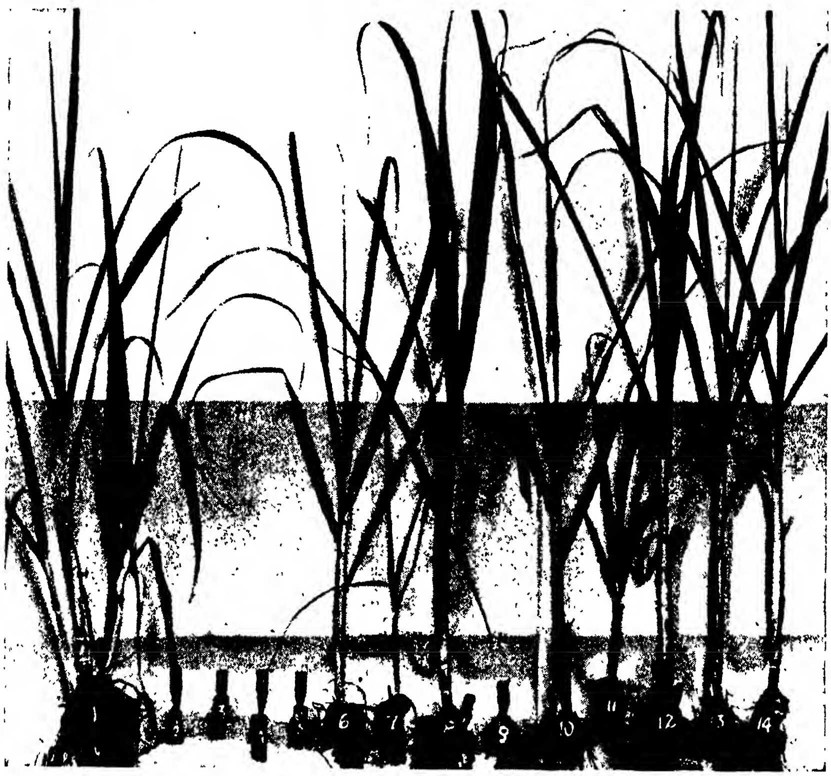

Fig. 6.—Shoots from the mosaiced stalk D of variety POJ 2878 sugar cane from which determination of presence or absence of virus was made. Eyes 1, 6 and 7 produced apparently mosaic-free shoots. Eyes 8, 10, 11, 12, 13 and 14 produced mosaiced shoots. On account of the small size of the photograph the symptoms are not shown in the figure. Eyes 2, 3, 4, 5 and 9 for unknown reason did not germinate.

The occurrence of apparently mosaic-free shoots from infected stalks. Of the 24 mosaic-infected POJ 2878 canes used, only one (stalk D), behaved differently from the other stalks of this and of all the other varieties. The buds that emerged from three of the eyes on nodes 1, 6 and 7 (fig. 6) produced leaves which were entirely free from mosaic symptoms. Buds 8, 10, 11, 12, 13 and 14 of the

same stalk developed shoots that showed clear mottling on the leaves. Eyes 2, 3, 4, 5 and 9, for unknown reasons, did not germinate. The occurrence of the three apparently free shoots from the infected stalk resembles the behavior towards grass mosaic of the POJ canes described by Stahl and Faris (1929 p. 7 and 9, fig. 2) who report that in resistant varieties like the POJ canes the mosaic is not distributed throughout the whole stalk. The healthy-looking plants obtained by these authors from mosaiced stalks remained healthy-looking through the first ratoon and seed pieces cut from these plants produced healthy-looking plants.

Determination of the presence or absence of infective material in apparently mosaic-free shoots. As Kunkel (1924b) reported that certain varieties of sugar cane recover from the mosaic disease, and recently, Ocfemia (1932) showed that in the native variety Linabnig the canes that did not exhibit mottling of the leaves contained the virus in their sap, experiments were carried out to determine if the apparently mosaic-free shoots from the infected stalk D of the 24 stalks of POJ 2878 canes tested did not have mosaic virus. Ocfemia (1932) found that the apparently mosaic-free Linabnig canes contained virus although they did not show symptoms of mosaic. Furthermore, compared with those that showed mottling on the leaves, this author noted that the plants from the apparently mosaic-free shoots of Linabnig were larger and taller than the shoots with the mottled leaves (Ocfemia, 1932, fig. 1).

In the present experiments, 12 shoots of Luzon White cane which came from one stalk were used. Nine seedlings, each one coming from one-node cutting, were inoculated on December 9, 1932, following Wilbrink's (1929) and Sein's (1930) method of sugar cane mosaic transmission by means of pin-pricks. The other three shoots, also coming from one-node cuttings, were used as checks. After an incubation period of 19 to 25 days three of the inoculated shoots, or 33.33 per cent, were infected while all the checks remained healthy. The result showed that the apparently mosaic-free shoots of stalk D of POJ 2878 canes had mosaic but they did not show symptoms of the disease. This result was strengthened by the fact that the checks remained healthy until February 3, 1933. For unknown reasons the other shoots did not become mosaiced. According to Kunkel (1928) "virus diseases seldom cause 100 per cent infection of field crops". He further states that "even in the worst cases of spread there are usually some plants that escape" infection. Recently Kunkel (1933) in his experiments on transmission of the peach

yellows with *Macropsis trimaculata* (Fitch.) as vector did not obtain more than ten per cent of infection.

Another experiment was conducted to check the results of the first transmission trial by pin pricks. Thirteen healthy shoots of Mauritius 1900 which came from one stalk were used. Eleven seedlings were inoculated on January 22, 1933 following the same method as before. On February 1 and 2, 1933, or after an incubation period of 10 to 11 days, three of the inoculated seedlings, or 27.27 per cent, showed infection while the checks were healthy. This confirmed earlier results that the apparently mosaic-free shoots of POJ 2878 and Linabnig canes (Ocfemia, 1932) had mosaic although the plants did not show symptoms of the disease. Johnson (1925) at Wisconsin reported that he was able to produce a virus disease on tobacco by inoculation with the sap of a healthy potato plant. Kunkel (1928), however, claimed that Johnson (1925) did not prove that the potatoes he used in his experiments contained the virus only the symptoms were not shown because they were masked. If Johnson's healthy potatoes were masked carriers of mosaic virus the apparently mosaic-free shoots of POJ 2878 may perhaps be classed in the same category.

Significance of this behavior in sugar cane culture. This characteristic of sugar cane towards grass mosaic may be of value in places where only mosaic-resistant varieties of canes are grown. This behavior of the cane, however, may have a distinct disadvantage in fields and localities where susceptible varieties of canes are also planted in adjacent fields. The cane plants which behave like stalk D of POJ 2878 mosaiced canes and Linabnig are constant sources of inoculum or hold-overs of the mosaic virus.

In mosaic-susceptible varieties of sugar cane the results obtained by the writers agree with those of Unite and Capinpin (1926) who concluded that within an infected stalk, the buds invariably produce infected shoots.

Occasional cases of apparently healthy cane stalks in Fiji diseased stools may be noted in the fields. Sooner or later, however, these stalks produce the typical Fiji disease symptoms. According to Cottrell-Dormer and Ferguson Wood (1927) in Queensland if these stools are ratooned every stalk produced shows Fiji infection. Similarly, if stems are taken from stools that received secondary infection and these stalks are used as source of cuttings for seed before the symptoms of Fiji disease become manifest, the stools arising from the cuttings show distinct Fiji-disease symptoms. Cottrell-Dormer and Ferguson Wood further report that the shoots are infected because the material used for planting was infected. The same results

were noted by the present writers in all of the varieties used in germination experiments.

The rare cases of stalks apparently free from Fiji disease in infected stools do not behave in a manner similar to the occasional apparently mosaic-free shoots in stalks of resistant varieties of sugar cane. In apparently mosaic-free nodes the mosaic-free looking stalks can be planted and produce healthy-looking shoots at germination. The shoots coming from ratoons of these stalks are also healthy looking. It is not known whether or not all of the shoots will produce mosaic-disease-free shoots if cuttings are taken from them for planting. In Linabnig cane, Ocfemia (1932) noted that in the second generation a few of the plants from the apparently mosaic-free shoots showed mosaic symptoms. It seems, however, that by gradual elimination of the canes that show symptoms a strain that does not show mottling, though it has the mosaic, may be produced. In apparently Fiji-disease-free stalks this freedom from symptoms and effects is only temporary in nature.

Conclusions. From the foregoing experiments it seems that the following conclusions are justified:

1. In the limited varieties of the native and introduced varieties of sugar cane used in the experiments the infective principle or virus of the mosaic and Fiji disease was found to be present in the shoot that developed from each of the eyes.

2. A very small proportion (four per cent) of the stalks from a mosaic-infected resistant sugar cane, POJ 2878, produced shoots from a few of the eyes that were free from mottling in the leaves. A similar behavior was not shown by any of the cane stalks infected with the Fiji disease.

3. The apparently mosaic-free shoots that developed from mosaic infected resistant POJ 2878 canes, when used as a source of inoculum in artificial transmission under controlled conditions, produced mottling in the leaves of some of the inoculated shoots.

EXPERIMENTS ON GERMINATION OF THE EYES OF HEALTHY, MOSAICED AND FIJI-INFECTED STALKS OF SUGAR CANE

A knowledge of the effect of either grass mosaic or Fiji disease on germination and growth of the eyes of a cane is of importance on account of the widespread distribution of these two diseases in the Philippines, the increasing popularity of the POJ canes and the different degrees of susceptibility to mosaic and Fiji diseases of the different varieties. Very little if any record is available to show whether or not all of the eyes of a cane grow with the same vigor as

the corresponding eyes of a healthy cane. Stahl and Faris (1929, p. 7 and fig. 2) obtained poor germination of the eyes of infected stalks in many cases, especially with varieties POJ 2727 and POJ 2725. Our experience with POJ 2727 at the College of Agriculture at Los Baños is that even with healthy stalks, single-eye cuttings produce poor germination. In the sereh disease of sugar cane (Lyon, 1921, p. 22) suspected canes may be singled out readily because the upper eyes of the stalks which have been topped are not capable of producing shoots. They remain dormant and do not germinate. According to Kunkel, 1928, in most cases virus diseases do not kill the host, although he (Kunkel, 1924b) states that grass mosaic may predispose sugar cane to the attack of red rot caused by *Colletotrichum falcatum* Went.

Materials and methods

Sugar cane varieties used. As in the experiments to study the distribution of mosaic and Fiji diseases, healthy stalks and Fiji-and mosaic-diseased canes of a few commercial varieties were secured for this study. The canes were obtained from different places; namely, Lemery and Nasugbu, Batangas, Del Carmen, Pampanga, Calamba Sugar Estate, Canlubang, Laguna and from the Experiment Station of the College of Agriculture at Los Baños and in its immediate vicinity. The varieties of sugar cane used and the number of stalks of each taken for germination studies are given in the following tabulation:

NAMES OF VARIETIES USED	NUMBER OF TRIALS MADE	NUMBER OF STALKS USED IN CONTROL	NUMBER OF STALKS WITH FIJI USED	NUMB OF STALI WITI MOSA USE
Luzon White	7	14	14	14
Pampanga Red	6	12	12	12
Mauritius 1900	6	12	12	12
POJ 2878	12	24	24	24
POJ 2727	7	14	14	—
Badila	6	12	12	12
Hawaii 109	4	8	8	8
Hawaii 227	4	8	8	8
New Guinea 24-A	4	8	8	8
New Guinea 24-B	4	8	8	8
Demarara 52	3	6	6	6
Queensland 409	3	6	6	6
U×D 1	2	4	4	—
P.S.A. 14	3	6	6	6
POJ 24	2	4	4	—

The preparation of the soil, selection and preparation of one-node cuttings were all done in the same way as in the experiments to determine the distribution of the mosaic and Fiji diseases in cane stalks.

In this work the criterion for germination of the eyes of the canes was emergence of the shoots through the soil. The shoots which were killed by fungous and insect attacks after emergence were considered germinated.

In the types of germination obtained in the tests, both strong and weak were observed. Strong germination is used to indicate that the young shoots came out early and grew vigorously, as shown by the long and large leaves, well developed root systems and in some cases production of young suckers. Weak germination signifies that the shoots produced were slender, the leaves narrow or short, usually few and pale green and the roots poorly developed.

Results

Germination of the eyes of healthy, mosaiced and Fiji-infected canes. The results [4] obtained by the writers from the comparative study of the germination of the eyes of healthy, mosaiced and Fiji-infected canes of the 15 commercial varieties of native and introduced sugar cane showed that in some varieties (1) the mosaic disease did not affect the germination of the eyes, (2) in others the disease reduced the percentage cf germination, and (3) in still others mosaic stimulated germination of the eyes. In regard to the effects of Fiji disease the following were noted: (1) in some varieties of canes the disease stimulated germination, (2) in others the disease reduced the germination of the buds considerably and (3) in still others Fiji disease did not affect germination. In many cases the differences in percentages of germination in favor or against the disease were significant. The results seem to show that the differences in percentages of germination can not be attributed to infection by the disease alone but to other factors which were not studied.

Relation of the age of the nodes to germination of the eyes. In all the germination experiments, the roots began to emerge from the older nodes on the fourth day and those of the younger nodes on the fifth day. By older nodes are meant the first five to six nodes of the stalk counting from the base of the plant, upwards. The shoots came out within 6 to 9 days in the younger or top nodes and in 11 to 44 days in the older nodes. Barber (1920) stated that the dif-

[4] Tables 1-31 containing the results of the experiments of Crispiniano C. Hernandez are filed with the original copy of his thesis with the Librarian of the College of Agriculture.

ference between old and young joints of the sugar cane stalks is that in the young tissues the cells are filled with sap for the building up of fresh tissues. The cells in the older joints are filled with sugar and they remain inert or inactive.

The greatest number of failures in germination and deaths of shoots occurred in the older nodes. No shoots in the younger or top nodes failed to germinate or died. Strong germination was always shown by the top nodes in all of the cane varieties used. Weak slender seedlings generally developed from the older nodes. The same results were obtained by Calma (1933). In the mosaic- and Fiji-infected canes the shoots from the basal to the top nodes of each stalk were stunted in growth. Compared with the growth of the shoots from the healthy stalks the mosaiced and Fiji canes showed very marked differences in the height of the stalks and length of leaves. The difference was especially conspicuous in the Fiji-infected seedlings.

In the germination studies in many of the eyes that did not germinate and occasionally in dead young shoots *Ceratostomella paradoxa* Dade, an undetermined species of *Fusarium* and *Pythium*, and in a few cases, nematodes, were associated. With the exception of the nematodes these organisms were, perhaps, either carried by the canes, or by wind. Spore-catching experiments conducted by us at various places on the farm of the College of Agriculture and at various times show that conidia of many fungi like *Cercospora, Septogloeum, Colletotrichum, Helminthosporium, Fusarium,* etc.; oospores of phycomycetes (possibly of *Sclerospora* from the wild sugar cane, *Saccharum spontaneum* L., etc.); chlamydospores of the sugar cane smut *Ustilago scitaminea* (Rabh.) Syd.) and urediniospores of rusts are often carried by the wind. The *Fusarium* was found frequently in the dead eyes, *Ceratostomella paradoxa* in the stalk and dead eyes and *Pythium* and nematodes (*Heterodera radicicola* (Greef) Müller) in the rotting roots.

THE TRANSMISSION OF MOSAIC AND FIJI DISEASES BY THE PIN-PRICK METHOD

The transmission to healthy canes of the infectious materials of mosaic and Fiji diseases by the pin-prick or mechanical method (Wilbrink, 1929 and Sein, 1930) will be found applicable in cane-breeding experiments. It affords a method for determining rapidly the relation of cane varieties to both of these diseases, and whether an apparently healthy shoot is free from the virus or the symptoms are merely masked.

Mosaic disease

A few varieties of sugar cane were used in transmission of mosaic disease by the pin-prick method of Wilbrink (1929), and Sein (1930) under carefully controlled conditions. The method of artificial transmission described by Matz (1933) was not tried in these experiments. The varieties used in inoculation experiments were Pampanga Red, Mauritius 1900, Luzon White, POJ 2727, POJ 2878, P. S. A. 14, New Guinea 24-A, and Queensland 409. The results of these experiments were as follows:

Pampanga Red. In this variety, 27 healthy shoots were inoculated and 17 shoots or 78.31 per cent were infected with an average incubation period of 18 days.

Mauritius 1900. Of the nine shoots that were inoculated, seven shoots or 77.77 per cent were infected with an average incubation period of 18.57 days.

Luzon White. Out of the 29 shoots inoculated, 15 shoots or 52.27 per cent were infected. The average incubation period was 17 days.

P.S.A. 14. Of the 12 shoots that were inoculated, three or 25 per cent became infected. The average incubation period was 26 days.

New Guinea 24-A. Seven healthy shoots were inoculated. Two became infected or 28.57 per cent. The average incubation period was 25 days.

POJ 2727. In this variety, 61 shoots which were free from mosaic were inoculated, but none of them became infected.

POJ 2878. In this variety, 25 healthy shoots were inoculated but none of them showed any symptom of mosaic infection.

Queensland 409. Of the seven shoots that were inoculated none became infected with mosaic.

In these inoculations POJ 2727, POJ 2878 and Queensland 409 were not infected but all the other varieties tested gave positive results. The control shoots used remained free from infection of the mosaic disease throughout.

On account of the rather easy transmission of the mosaic disease by the mechanical or pin-prick method there is need of exercising care not to use the same knife for cutting infected or doubtful canes, and for preparing tops or cut-back seed pieces for planting purposes without disinfecting it. If a knife has been used for cutting mosaiced canes it should be sterilized with 1:1000 mercuric chloride solution or other disinfectants in order to remove the virus from the blade.

Fiji disease

The transmission of Fiji disease to healthy shoots was tried a number of times using the eight varieties of sugar cane tested for mosaic infection. The pin-prick method was followed in these experiments. The results of the experiments, however, show that the Fiji disease can not be transmitted by the mechanical methods which will communicate the grass mosaic disease. Mungomery and Bell (1933) also report negative results with this method of Fiji transmission. From this result it seems that there is little danger of transmitting Fiji disease by the use of a knife that had been employed for cutting Fiji-infected stalks.

SUMMARY

1. The mosaic and Fiji diseases are two of the major diseases of sugar cane in the Philippines. They cause enormous losses to the sugar industry.

2. The mosaic disease is shown by mottling of the leaves. The mottled areas may be elongated into streaks but these do not continue to form stripes. The streaks are lengthwise with the leaves. In some varieties of sugar cane, cankers of the stem are additional symptoms.

3. The most characteristic symptom of Fiji disease is the presence of elongated galls on the veins. These galls are very conspicuous on the nether surface of the leaves and on the leaf sheaths. The leaves become short, narrow, brittle and tend to tear into strips. The color is darker green than that of healthy plants.

4. Both mosaic and Fiji disease are caused by virus. The mosaic disease is transmitted by *Aphis maidis* Fitch. and by pinpricks or mechanical means. In the Philippine Islands Fiji disease is transmitted by *Perkinsiella vastatrix* Breddin and in Australia *P. saccharicida* Kirk. is said to be the vector. Germination experiments of one-node cuttings of 16 commercial varieties of native and introduced canes show that the mosaic and Fiji diseases of sugar cane are distributed throughout the entire stalks of the infected plants.

5. All shoots coming from the buds of all the mosaic-infected stalks of POJ canes used in the present work showed mosaic symptoms except those from buds 1, 6 and 7 of the stalk D of POJ 2878. Transmission experiments to susceptible cane varieties using the apparently mosaic-free POJ 2878 shoots of stalk D as source of inoculum showed that the absence of mottling in the leaves is not due to absence of the mosaic virus but to a masking of the symptoms.

6. The stalks, apparently free from Fiji disease, in the Fiji-infected stools are not of the same nature as the apparently mosaic-free canes. They show the symptoms of Fiji disease later or when the stalks are planted.

7. A study of the germination of the eyes of healthy, mosaiced and Fiji-infected stalks using 15 commercial varieties of both native and foreign canes showed that (*a*) in some varieties the healthy canes gave higher percentage of germination of the eyes than mosaiced and Fiji-infected canes; (*b*) in others the healthy stalks produced lower percentages of germination of eyes than Fiji-infected and mosaiced stalks; and (*c*) in still others the presence of the disease did not materially affect the germination of the eyes. The results seem to indicate that factors other than presence of Fiji disease or mosaic disease influence the germination of sugar cane buds.

8. In all cases shoots emerged earlier from the top nodes than from the lower nodes, although the roots came out earlier in older nodes than in younger. Moreover, strong germination was produced by the top nodes and weak and slender shoots appeared from the older lower nodes. Failure of germination of the eyes or death of shoots generally occurred in the older nodes of the stalks.

9. In addition to old age, failure of germination of the eyes was perhaps caused, in part at least, by the associated *Ceratostomella paradoxa* Dade, *Pythium*, sp. and nematodes.

10. The mosaic of sugar cane was easily transmitted by the pin-prick method to varieties Pampanga Red, Mauritius 1900, Luzon White, P. S. A. 14, New Guinea 24-A. Varieties POJ 2878, POJ 2727 and Queensland 409 could not be infected when inoculated by the pin-prick method. Fiji disease could not be transmitted by the pin-prick method.

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CHEMICAL ANALYSIS FOR POSSIBLE SOURCES OF OILS OF FORTY-FIVE SPECIES OF OIL-BEARING SEEDS [1]

SALVADOR P. PADILLA AND FLORENCIO A. SOLIVEN

There is a great variety of plants in the Philippines in a wild or semi-wild state; undoubtedly a large number of them bear fruits which would yield useful oils. A number of medicinal plants which contain oils are cultivated. There are also a few plants from which oils are extracted for local use, some of which enter into foreign commerce. One, coconut oil, is very important in the commerce of the Islands and is the basis of important domestic industries. Another oil which may in the future command a place of importance in foreign commerce is lumbang oil; at present it is crudely produced for soap and paint manufacture. There may be other plants that would prove to be sources of oils equally as good as coconut and lumbang.

A systematic chemical study of oil-bearing seed plants found in the Philippines to determine their usefulness should be very important. A number of these seeds have been analyzed for the amount of oil they contain. In table 1 is given the names of the plants, the names of the workers, and the results of these analyses. With a few exceptions the results are, however, far from complete.

The study, the results of which are presented in this paper, had for its object the determination of the proximate chemical analysis of oil-bearing seeds of forty-five species of Philippine plants.

The work was carried out in the Department of Agricultural Chemistry, College of Agriculture from November 30, 1931 to December 10, 1933.

MATERIALS AND METHODS

Seed oils

The species of oil-bearing seeds used in this study were obtained from the School of Forestry, the College of Agriculture, and in Peñaranda, Nueva Ecija. The following were the seeds used in this study [2].

[1] The data used in this paper formed part of the thesis presented by the senior author for graduation, 1933, with the degree of Bachelor of Science in Agriculture from the College of Agriculture No. 365; Experiment Station contribution No. 911.

[2] These different species of oil-bearing seeds were identified by Mr. Mamerto Sulit, of the School of Forestry and Dr. José B. Juliano of the Department of Plant Physiology, College of Agriculture.

1. *Aleurites moluccana* (Linn.) Willd., lumbang (Tag.)
2. *Aleurites trisperma* Blanco, baguilumbang (Tag.)
3. *Anacardium occidentale* Linn., balubad (Tag.)
4. *Arachis hypogaea* Linn., mani (Sp.)
5. *Caesalpinia crista* Linn; kalumbibit (Tag.)
6. *Calophyllum inophyllum* Linn., bitaog (Il.)
7. *Canarium ovatum* Engl., pili (Tag.)
8. *Ceiba pentandra* (Linn.) Gaertn., bulak (Tag.)
9. *Chisocheton cumingianus* (C. Dc.) Harms, balukanag (Tag.)
10. *Chisocheton pentandrus* (*Blanco*) Merr., catongmatsing (Tag.)
11. *Chrysobalanus icaco* Linn., icaco (Tag.)
12. *Cinnamomum mercadoi* Vid., calingag (Tag.)
13. *Cocos nucifera* Linn., niog (Tag.)
14. *Croton tiglium* Linn., camaisa (Tag.)
15. *Delonix regia* (Boj.) Raf., fire tree.
16. *Dysoxylum decandrum* (Blanco) Merr., taliktan (Tag.)
17. *Entada phaseoloides* (Linn.) Merr., bayugo (Tag.)
18. *Gliricidia sepium* (Jacq.) Steud., madre de cacao. (Sp.)
19. *Gossypium* sp. cotton seed
20. *Heritiera littoralis* Dryando, duñgonlate (Tag.)
21. *Hevea brasiliensis* (HBK.) Muell-Arg., Para rubber.
22. *Hydnocarpus alcalae* C. DC., dudra (Bicol)
23. *Hydnocarpus hutchinsonii* Merr., bagarbas (Lan.)
24. *Intsia bijuga* (Colebr.) O. Kuntze, Ipil (Tag.)
25. *Jatropha curcas* Linn., tuba (Tag.)
26. *Leucaena glauca* (Linn.) Benth., ipilipil (Tag.)
27. *Mallotus philippensis* (Lam.) Muell.-Arg., banato (Tag.)
28. *Moringa oleifera* Lam., malongai (Tag.)
29. *Nephelium mutabile* Blume, bulala (Tag.)
30. *Orania palindan* (Blanco) Merr., niogniogan (Tag.)
31. *Pachyrrhizus erosus* (Linn.) Urb., sincamas (Tag.)
32. *Pahudia rhomboidea* (Blanco) Prain, tindalo (Tag.)
33. *Pangium edule* Reinw., pangi (Bicol)
34. *Parashorea malaanonan* (Blanco) Merr., lauanpute (Tag.)
35. *Parkia javanica* (Lam.) Merr., kupang (Tag.)
36. *Pithecolobium dulce* (Roxb.) Benth., camanchile (Tag.)
37. *Pongamia pinnata* (Linn.) Merr., bani (Tag.)
38. *Psophocarpus tetragonolobus* (Linn.) DC., calamismis (Tag.)
39. *Ricinus communis* Linn., tañgan-tañgan (Tag.)
40. *Samanea saman* (Jacq.) Merr., acacia (Sp.)
41. *Sesamun orientale* Linn., liñga (Tag.)
42. *Sesbania grandiflora* (Linn.) Pers., caturai (Tag.)
43. *Sterculia foetida* Linn., calumpang (Tag.)
44. *Swietenia mahogoni* Jacq., mahogany.
45. *Tamarindus indica* Linn., sampaloc (Tag.)

Methods

Sampling. From two to five kilograms, depending on the supply, of representative samples of each species of seeds were collected

and put in separate containers. The samples were identified previous to analysis.

Determination of kernel. A known weight of each of the samples was taken and the shells removed. The weight of the kernel was found and from these data the percentage of kernel was calculated.

The preparation of the sample for analysis. The analyses here reported were based on the kernels. The kernels which could be reduced to powder were ground in a porcelain mortar and passed through a sieve having a mesh of one millimeter in diameter. To prevent undue loss of moisture from the sample, the grinding and sifting were done as quickly as possible. The ground materials were stored in well-stoppered containers.

The kernels that were plastic were ground in a porcelain mortar until they were reduced to a fine doughy mass. This grinding was also done as quickly as possible to prevent loss of moisture through evaporation.

Chemical analysis. The methods of chemical analysis were in accordance with the directions embodied in the *Official and Tentative Methods of Analysis of the Association of Official Agricultural Chemists* (1925).

Triplicate determinations for each constituent of the different species of the oil-bearing seeds were made. The averages of concordant determinations are reported in table 2.

RESULTS

The results of the analysis of the forty-five species of oil-bearing seeds are given in tables 2 and 3.

1. The percentage of kernels varied considerably, the range being from 16.82 per cent for *Canarium ovatum* to 100.00 per cent for *Sesamum orientale.*

2. The range of moisture in the kernels of the seeds analyzed was from 2.43 per cent for *Chrysóbalanus icaco* to 48.46 per cent for *Cocos nucifera.*

3. The mineral or ash from the kernels of the different species of seeds varied from 1.48 per cent in *Calophyllum inophyllum* to 7.92 per cent in *Delonix regia.*

4. The amount of crude protein varied in different seeds, the range being from 6.30 per cent in *Orania palindan* to 76.13 per cent in *Sesbania grandiflora.*

5. The amount of crude fat in different species varied considerably, ranging from 1.57 per cent for *Orania palindan* to 84.00 per cent for *Callophyllum inophyllum.*

6. The amount of carbohydrates varied from 3.91 per cent in *Gliricidia sepium* to 90.35 per cent in *Orania palindan*.

7. The following seeds were found to yield a greater amount of oil per kilogram of seeds than lumbang seeds: *Nephelium mutabile, Cinnamomum mercadoi, Chisocheton cumingianus, Calophyllum inophyllum, Jatropha curcas, Hydnocarpus alcalae* and *Pongamia pinnata*. The following seeds were found to yield a greater amount of oil per kilogram of seeds than coconut: *Swietenia mahogoni, Moringa oleifera, Gliricidia sepium, Pañgium edule* and *Hevea brasiliensis*. It is recommended that the oils be studied for possible use.

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TABLE 1

Collected analyses of oil-bearing seeds

	WORKERS	KERNELS	MOISTURE	ASH	PROTEIN	FATS	CARBO-HYDRATES
		per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
Aleurites moluccana	Aguilar (1919)	—	11.13	—	53.38	—	—
	Lewkowitsch (1901)	—	—	—	—	62 – 64	—
Aleurites trisperma	Aguilar (1919)	—	7.67	—	38.75	—	—
Arachis hypogaea	Laucks (1919)	—	—	—	—	40 – 60	—
	Lewkowitsch (1901)	—	—	—	—	43 – 45	—
Callophyllum inophyllum	Soliven (1927)	50.24	39.20	1.70	2.90	43.90	5.90
Canarium ovatum	Brill and Agcaoili (1910)	—	2.79	2.97	12.06	74.79	—
Chisocheton cumingianus	Brill and Agcaoili (1910)	—	—	3.19	9.00	40.12	—
Cocos nucifera	Lewkowitsch (1901)	—	—	—	—	45 – 63	—
	Adriano and Manahan (1931)	35.38	50.56	1.19	31.12	3.21	10.86
Croton tiglium	Lewkowitsch (1901)	—	—	—	—	53 – 56	—
Gossypium hirsutum	Laucks (1919)	—	—	—	—	34 – 39	—
Jatropha curcas	Soliven (1928)	58.12	56.80	4.86	23.35	51.89	10.71
	Lewkowitsch (1901)	—	—	—	—	55 – 57	—
Moringa oleifera	Lewkowitsch (1901)	—	—	—	—	35 – 36	—
Ricinus communis	Andes (1917)	—	—	—	—	40 – 45	—
	Laucks (1919)	—	—	—	—	45 – 55	—
	Lewkowitsch (1901)	—	—	—	—	46 – 53	—
Sesamum orientale	Laucks (1919)	—	—	—	—	50 – 57	—
	Lewkowitsch (1901)	—	—	—	—	50 – 57	—
Sterculia foetida	Brill and Agcaoili (1910)	—	—	3.90	21.61	51.78	—

TABLE 2

Showing the proximate chemical composition of the kernels of forty-five species of Philippine oil-bearing seeds

SCIENTIFIC NAMES	KERNELS	MOISTURE	ASH		PROTEINS (N × 6.25)		CRUDE FATS (ETHER EXTRACT)		TOTAL CARBOHYDRATES	
			Fresh basis	Dry basis	Fresh basis	Dry basis	Fresh basis	Dry basis	Fresh basis	Dry basis
	per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
Aleurites moluccana (Linn.) Willd.	34.17	2.54	3.27	3.35	25.56	26.22	63.53	65.18	5.10	5.25
Aleurites trisperma Blanco	65.62	3.65	3.22	3.34	23.31	24.19	38.97	40.44	30.90	32.03
Anacardium occidentale Linn.	30.82	7.55	2.60	2.81	25.41	27.48	43.39	46.93	21.05	22.78
Arachis hypogaea Linn.	92.00	4.58	2.57	2.69	42.77	44.82	42.03	44.04	8.05	8.45
Caesalpinia crista Linn.	48.81	4.66	3.45	3.62	21.19	22.22	20.56	21.56	50.14	52.60
Calophyllum inophyllum Linn.	53.15	27.73	1.07	1.48	6.41	8.87	60.72	84.00	4.07	5.65
Canarium ovatum Engl.	15.82	4.16	2.99	3.12	16.53	17.25	72.01	75.14	4.31	4.49
Ceiba pentandra (Linn.) Gaertn.	59.99	8.84	5.40	5.92	47.53	52.14	34.48	37.82	3.75	4.12
Chisocheton cumingianus (C.DC.) Harms	58.20	4.40	2.65	2.77	16.38	17.13	67.46	70.56	9.11	9.54
Chisocheton pentandrus (Blanco) Merr.	87.13	12.19	2.41	2.74	13.50	15.37	13.27	15.11	58.63	66.78
Chrysobalanus icaco Linn.	52.32	2.43	1.72	1.76	10.74	11.01	21.27	21.80	63.83	65.43
Cinnamomum mercadoi Vid.	90.42	16.35	1.71	1.94	31.77	37.87	43.45	51.95	6.72	8.24
Cocos nucifera Linn.	54.24	48.46	0.98	1.90	5.39	10.46	31.61	61.32	13.56	26.32
Croton tiglium Linn.	65.63	4.51	3.18	3.33	38.30	40.11	37.17	38.92	16.84	17.64
Delonix regia (Boj.) Raf.	24.74	6.37	7.42	7.92	60.31	64.41	9.68	10.34	16.22	17.33
Dysoxylum decandrum (Blanco) Merr.	75.00	46.77	1.87	3.51	8.90	16.72	1.45	2.72	42.01	77.05
Entada phaseoloides (Linn.) Merr.	55.36	9.09	2.27	2.50	23.53	25.88	2.07	2.28	63.04	69.34
Gliricidia sepium (Jacq.) Steud.	84.54	13.16	3.53	4.06	53.80	61.95	26.12	30.08	3.39	3.91
Gossypium sp.	56.80	10.48	5.28	5.90	38.53	43.04	34.09	38.08	11.62	12.98
Heritiera litteralis Dryand	60.48	46.27	1.46	2.72	4.34	8.08	5.34	9.94	42.59	79.26
Hevea brasiliensis (HBK.) Muell.-Arg.	49.91	11.49	2.98	3.26	18.53	19.94	40.51	45.77	26.49	31.03
Hydnocarpus alcalae C.DC.	61.40	34.34	2.89	4.40	13.84	21.08	44.27	67.42	4.66	7.10
Hydnocarpus hutchinsonii Merr.	31.11	9.74	3.20	3.55	17.74	19.65	55.39	61.37	13.93	15.43

TABLE 2 (Continued)

SCIENTIFIC NAMES	KERNELS	MOISTURE	ASH		PROTEINS (N × 6.25)		CRUDE FATS (ETHER EXTRACT)		TOTAL CARBOHYDRATES	
			Fresh basis	Dry basis	Fresh basis	Dry basis	Fresh basis	Dry basis	Fresh basis	Dry basis
	per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
Intsia bijuga (Colebr.) O.Kuntze	78.62	23.74	2.50	3.18	11.12	14.58	11.16	14.46	51.48	67.61
Jatropha curcas Linn.	63.46	4.65	3.87	4.06	31.83	33.38	46.40	48.66	13.25	13.90
Leucaena glauca (Linn.) Benth.	52.50	13.68	5.41	6.27	57.30	66.38	13.18	15.27	10.43	12.08
Mallotus philippensis (Lam.) Muell.-Arg.	48.46	6.33	2.67	2.85	28.27	30.18	11.25	12.01	51.48	54.96
Moringa oleifera Lam.	68.97	6.52	3.16	3.38	46.56	49.81	32.60	34.87	11.16	11.94
Nephelium mutabile Blume	89.66	9.07	2.61	2.87	15.45	16.99	58.18	63.98	14.69	16.16
Orania palindan (Blanco) Merr.	80.75	27.46	1.29	1.78	4.57	6.30	1.14	1.57	65.54	90.35
Pachyrrhizus erosus (Linn.) Urb.	80.16	8.11	4.32	4.70	39.50	42.99	25.81	28.09	22.26	24.22
Pahudia rhomboidea (Blanco) Prain	77.00	18.35	2.47	3.25	13.45	16.47	8.10	9.92	57.63	70.36
Pañgium edule Reinw.	57.00	21.80	1.62	2.07	11.24	14.37	38.50	49.23	26.84	34.33
Parashorea malaanonan (Blanco) Merr.	84.24	36.37	1.35	2.12	4.27	6.71	2.91	4.57	55.10	86.60
Parkia Javanica (Lam.) Merr.	45.39	6.56	5.51	5.90	39.74	42.53	18.89	20.22	29.30	31.35
Pithecolobium dulce (Roxb.) Benth.	70.56	21.76	2.26	2.89	29.89	38.20	17.69	22.61	28.40	36.30
Pongamia pinnata (Linn.) Merr.	94.13	12.41	3.05	3.49	23.29	26.59	28.63	32.68	32.62	37.24
Psophocarpus tetragonolobus Linn.) DC.	85.44	8.54	5.27	5.76	41.86	45.77	13.11	14.33	31.22	34.14
Ricinus communis Linn.	68.63	5.14	3.85	4.06	30.61	32.27	53.67	56.57	6.73	7.10
Samanea saman (Jacq.) Merr.	51.05	11.83	2.93	3.39	59.72	67.73	11.16	12.66	14.36	16.22
Sesamum orientale Linn.	100[a].00	5.79	6.37	6.76	29.50	31.31	43.25	45.91	15.09	16.02
Sesbania grandiflora (Linn.) Pers.	55.29	10.39	5.48	6.12	68.22	76.13	7.09	7.91	8.82	9.84
Sterculia foetida Linn.	39.96	8.37	3.37	3.68	23.44	25.58	50.26	54.85	14.56	15.89
Swietenia mahogeni Jacq.	39.69	4.36	2.77	2.89	15.81	16.52	60.19	62.90	16.87	17.69
Tamarindus indica Linn.	70.49	13.13	2.37	2.73	19.69	22.67	5.54	6.38	59.27	68.22

[a] The shells were not removed since for practical purposes they are edible.

TABLE 3

Showing the amount of kernels, crude protein and crude fats that could be obtained from one kilogram of seeds

SCIENTIFIC NAMES	KERNELS	CRUDE PROTEIN	CRUDE FATS
	grams	*grams*	*grams*
Aleurites moluccana (Linn.) Willd.	342	87	217
Aleurites trisperma Blanco	656	154	256
Anacardium occidentale Linn.	308	78	134
Arachis hypogaea Linn.	920	393	387
Caesalpinia crista Linn.	488	103	100
Calophyllum inophyllum Linn.	532	34	323
Canarium ovatum Engl.	158	26	114
Ceiba pentandra (Linn.) Gaertn.	600	285	207
Crisocheton cumingianus (C.DC.) Harms	582	95	393
Chisocheton pentandrus (Blanco) Merr.	871	118	116
Chrysobalanus icaco Linn.	523	56	111
Cinnamomum mercadoi Vid.	904	287	393
Cocos nucifera Linn.	542	29	172
Croton tiglium Linn.	656	251	263
Delonix regia (Boj.) Raf.	247	149	24
Dysoxylum decandrum (Blanco) Merr.	750	67	11
Entada phaseoloides (Linn.) Merr.	554	130	12
Gliricidia sepium (Jacq.) Steud.	845	455	221
Gossypium sp.	568	219	194
Heritiera litteralis Dryand.	605	26	32
Hevea brasiliensis (HBK.) Muell.-Arg.	499	93	202
Hydnocarpus alcalae C.DC.	614	85	272
Hydnocarpus hutchinsonii Merr.	311	55	172
Intsia bijuga (Colebr.) O. Kuntze	786	87	88
Jatropha curcas Linn.	635	202	295
Leucaena glauca (Linn.) Benth.	525	301	69
Mallotus philippensis (Lam.) Muell.-Arg.	485	137	55
Moringa oleifera Lam.	690	321	225
Nephelium mutabile Blume	891	139	522
Orania palindan (Blanco) Merr.	808	37	9
Pachyrrhizus erosus (Linn.) Urb.	802	317	207
Pahudia rhomboidea (Blanco) Prain	770	104	62
Pañgium edule Reinw.	570	64	220
Parashorea malaanonan (Blanco) Merr.	842	36	25
Parkia javanica (Lam.) Merr.	454	180	86
Pithecolobium dulce (Roxb.) Benth.	706	211	125
Pongamia pinnata (Linn.) Merr.	941	219	270
Psophocarpus tetragonolobus (Linn.) DC.	854	358	112
Ricinus communis Linn.	686	210	368
Samanea saman (Jacq.) Merr.	510	305	57
Sesamum orientale Linn.	1000	291	433
Sesbania grandiflora (Linn.) Pers.	553	377	39
Sterculia foetida Linn.	400	94	201
Swietenia mahogoni Jacq.	397	63	239
Tamarindus indica Linn.	705	139	39

A STUDY ON THE COMPARATIVE ECONOMY OF EGG PRODUCTION OF THE NAGOYA AND OF THE LOS BAÑOS CANTONESE BREEDS OF FOWLS [1]

LADISLAO G. MARTIR

In a previous report (Tioaquen, 1933), the growth and maturity of the Los Baños Cantonese and of the Nagoya breeds of fowls were compared. As many of the poultry raisers around Manila and in the neighboring provinces are concentrating their attention on these two imported breeds, the question as to which of them produces eggs the most economically becomes an important one. For this reason this study on the comparative economy of egg production by these breeds which was conducted in the Poultry Division of the Animal Husbandry Department is timely and should be of value. It covered a period of 366 days from September 1, 1931 to August 31, 1932.

REVIEW OF LITERATURE

Fronda and Gonzalez (1927) reported that the average yearly egg production of the Los Baños Cantonese pullets in the College of Agriculture in 1917 to 1918 was 29.8 eggs and in 1923 to 1924 was 109.7 eggs. In 1929, they reported that the yearly egg production in 1927 of the four Nagoya pullets that were produced out of the 30 Nagoya eggs imported from Japan in 1926 were 106, 98, 91 and 74 eggs. This record, for a newly imported breed, was considered satisfactory.

Fronda and Paje (1930) reported that among the Los Baños Cantonese chickens it cost 38.8 centavos to produce a dozen eggs from pullets, 43.6 centavos from yearlings and 49.0 centavos from hens. They stated that of these costs, 60.3 per cent represented the cost of feeds; 18.6 per cent, labor; 6.8 per cent, use of fences and building; 4.2 per cent, use of capital stock; 3.7 per cent, depreciation; 3.8 per cent, insurance; 2.3 per cent, repairs; and 0.3 per cent, use of land.

Fronda (1931) reported that in the First Philippine Egg Laying Contest held in 1930-1931, the feed consumption per bird was 31.15

[1] Thesis presented for graduation, 1933, with the degree of Bachelor of Science in Agriculture from the College of Agriculture, No. 366; Experiment Station contribution No. 912. Prepared in the Department of Animal Husbandry under the direction of Dr. F. M. Fronda.

kgm. for the Nagoya chickens and only 27.43 kgm. for the Los Baños Cantonese. He further stated that the returns above the cost of feeds ranged from ₱38.72 to ₱56.43 for the three Los Baños Cantonese lots entered and ₱48.56 and ₱53.18 for the two Nagoya lots. The Los Baños Cantonese laid a larger number of eggs but the eggs were rather small so that the income was not as large as that from the Nagoya pens. Each pen in the contest consisted of ten birds.

MATERIALS AND METHODS

Thirty Los Baños Cantonese pullets and 30 Nagoya pullets were placed in separate pens. The chickens were about six months old when placed in the pens. They were selected from the College flocks that were hatched during the same season of the year. Two roosters were placed in each lot. Both lots were given the same ration during the whole year. The grain feed consisted of equal parts by weight of corn and palay, and the mash feed consisted of two parts shrimp meal, one part corn meal, one part copra meal and six parts rice bran.

Effort was made to have the birds consume equal parts of grain and mash. The monthly feed consumption for each pen was recorded. Grain was given to the birds in the morning and afternoon and wet mash some time before noon. Dry mash was open to the birds at all times during the day. Fresh water was available at all times.

The hens were weighed at the beginning of the experiment and every month thereafter. Those which showed signs of broodiness were confined at once in the broody coop and released after broodiness was broken, which was in from four to five days. The weights and mortality of the birds were recorded.

The eggs were collected from the trap nests at about 9:00 and 11:00 a. m. and 1:00 and 4:00 p. m. All the unidentified eggs, "out eggs", were included in the computation for the pen production. The eggs were classified and sold as table eggs according to the College classification which is as follows: eggs that weigh less than 45 grams each are recorded as "undergrade" or "pullet" eggs, and those that weigh 45 grams each or over are recorded as "standard" eggs. The undergrade eggs were sold at ₱.03 each and the standard eggs were sold at ₱0.04 each.

Only normal eggs were incubated. An equal number of eggs of the Nagoya and the Los Baños Cantonese lots were incubated in the same incubator and at the same time. Three trials were made and the combined results of the three trials are here reported.

Cost factors

To determine the net cost of production the following cost figures used by Fronda and Paje (1930) were used:

Labor. The actual amount of labor required for the care and management of the pens was used. On an average one and one-half hours a day were needed for both pens. At ten centavos an hour, ₱54.90 was charged for labor against the two pens for 366 days or ₱27.45 against each pen.

Use of building and fences. The present book value of the house and fences is ₱388.89. This value is rather high but the records show that this house was built when labor was high and materials expensive. At six per cent a year as rent, ₱23.33 was charged against the two lots or ₱11.66 against each pen.

Interest on capital stock. The local selling price of a Nagoya pullet is ₱6.00 and that of a Los Baños Cantonese pullet is ₱3.00. The 30 birds in the Nagoya lot therefore cost ₱180.00 and the 30 birds in the Los Baños Cantonese lot cost ₱90.00. At the rate of six per cent per annum as interest, ₱10.80 was charged against the Nagoya pen and ₱5.40 against the Los Baños Cantonese pen.

Depreciation. Taking 3.3 per cent on the present value of the building and fences as depreciation, the amount of ₱12.83 was charged against the two lots or ₱6.41 against each pen.

Insurance. At the rate of five per cent per annum as insurance, the annual insurance for each lot was ₱9.00 for the Nagoya and ₱4.50 for the Los Baños Cantonese lot. At 0.25 per cent per annum, the insurance for the building was ₱0.97 or ₱ 0.49 was charged against each pen. Thus the sum of ₱9.49 was charged against the Nagoya pen and ₱4.99 against the Los Baños Cantonese pen for insurance of both the birds and the building.

Repairs. For the repair of building and fences the rate of two per cent was used. The amount that was charged against each pen was ₱3.88.

Use of land. The four adjoining yards, including the place where the building is located, covers about 720 square meters. At ₱500.00 a hectare and with the interest at six per cent, ₱1.08 was charged against each pen for rent of land.

RESULTS AND DISCUSSIONS

Percentage of monthly egg production. The percentage of monthly egg production of the two lots is shown in table 1. Referring to this table it may be seen that each of the two lots produced practically the same number of eggs throughout the year except in

September when the Los Baños Cantonese pen produced 44.8 per cent, while the Nagoya pen produced only 32.8 per cent. These productions during September were expected because the Los Baños Cantonese are earlier maturing birds than the Nagoya (Tioaquen, 1933). The difference between the two lots in the percentage of egg production during the month was 12.0 per cent.

There was a decrease in egg production in October. The decrease in the Los Baños Cantonese was because many of the birds were broody. There was a steady increase in egg production in the two lots from November to January and then up to August a gradual decrease. Similar observations were reported by Fronda (1928). The percentage of egg production increased from September to January and then up to August it gradually decreased.

The average yearly percentage of egg production was determined; it was observed that there was hardly any difference between the two breeds. On an average, a Nagoya hen laid 134.8 eggs in one year and a Los Baños Cantonese hen laid 136.0. The range in individual egg production during the year varied from 80 to 177 eggs in the Nagoya lot and from 100 to 191 eggs in the Los Baños Cantonese lot.

In the Nagoya lot, one hen laid 80 eggs, six hens laid from 110 to 119 eggs; four hens, from 130 to 139 eggs; three hens, from 140 to 149 eggs; two hens, from 160 to 169 eggs; and one hen, from 170 to 179 eggs. In the Los Baños Cantonese lot, two hens laid from 100 to 109 eggs; four hens, from 110 to 119 eggs; five hens, from 120 to 129 eggs; eight hens, from 130 to 139 eggs; two hens, from 140 to 149 eggs; two hens, from 150 to 159 eggs; two hens, from 170 to 179 eggs; and one hen, laid 191 eggs.

If the egg production of only the birds that completed the year is considered, the average production per bird in the Nagoya lot would be 131.8 eggs and that in the Los Baños Cantonese lot would be 134.6 eggs. The figures are slightly lower in both lots when computed on the basis of the birds that completed the year than when the averages for the lots are considered, owing to the fact that some of the birds that died happened to be heavy producers. While both bases of computations are correct, in fairness to each of the two lots studied, the figures, 134.8 eggs for the Nagoya lot and 136.0 for the Cantonese, should be taken as the correct figures for the average egg production of each lot.

Number and value of eggs produced. Table 2 shows the actual number and the value of eggs produced in each of the two lots. Out of the 3356 eggs laid by the Nagoya pen, 1641 eggs, or 45.89 per cent,

were standard eggs; of the 3726 eggs of the Los Baños Cantonese only 251 eggs or 13.98 per cent were standard eggs. The Nagoya eggs that were produced cost a total of ₱117.09 and the Los Baños Cantonese eggs cost a total of ₱116.99. The Los Baños Cantonese lot produced more eggs than the Nagoya lot but the income was lower than that of the Nagoya lot because the Los Baños Cantonese eggs were rather small. The results were to be expected because the Nagoya pen produced larger eggs than the Los Baños Cantonese pen.

Feed consumption. Referring to table 3 it may be seen that the Nagoya lot consumed 407.8 kgm. of mash and 406.5 kgm. of grain or a total of 814.3 kgm. of feeds during the year. At the current prices of feeds, a kilogram of the mash mixture cost ₱0.064 and a kilogram of the grain mixture cost ₱0.048. The total cost of feeds consumed by the Nagoya lot, therefore, was ₱45.62. Computing the feed consumption on the basis of the individual bird, it may be seen that the average consumption for each bird in the Nagoya lot was 16.4 kgm. of the grain mixture and 16.3 kgm. of the mash mixture or a total of 32.7 kgm. of feeds a year, valued at ₱1.84. Computing the feed consumption on the basis of a kilogram live weight, the average consumption of each bird in the Nagoya lot for the year was 9.6 kgm. of mash mixture and 9.67 kgm. of grain or a total of 19.27 kgm. of feeds valued at ₱1.08.

Referring to the same table, it may be seen that the Los Baños Cantonese lot consumed 398 kgm. of the mash mixture and 401 kgm. of the grain mixture or a total of 799 kgm. of feeds valued at ₱44.72. The average consumption per bird for the year was 14.5 kgm. of the mash mixture and 14.6 kgm. of the grain mixture or a total for the year of 29.1 kgm. of feeds valued at ₱1.63. Computing the feed consumption on the basis of a kilogram live weight, the average consumption in the Los Baños Cantonese lot was 9.6 kgm. of mash mixture and 9.68 kgm. of grain mixture or a total of 19.28 kgm. of feeds costing ₱1.08.

The results clearly show that there is no significant difference in the feed consumption of the two lots if the feed consumption is based on a kilogram live weight. But if the feed consumption is based on the average per individual bird, the Nagoya lot consumed 12.8 per cent more feeds than the Los Baños Cantonese lot. Fronda (1931) reported that for the Nagoya hen the annual feed consumption was 31.15 kgm., while for the Los Baños Cantonese hen it was only 27.43 kgm.

Cost of egg production including the different charges made

Value of eggs over the cost of feeds. Table 4 shows the returns from the sale of eggs, and the cost of feeds needed to produce a dozen eggs. Actually, the Nagoya lot produced a smaller number of eggs than the Los Baños Cantonese and the total feed consumption was more. The returns from the sale of eggs over the cost of feeds would have been the same in the two lots if the lots had produced eggs of the same size. The actual returns received from the sale of eggs from the Nagoya lot was ₱71.47 more than the cost of feeds; for the Los Baños Cantonese lot, ₱72.27, thus giving ₱0.80 in favor of the latter lot.

Profit. Table 4 gives the summary of the actual expenses incurred in each lot of 30 birds. The total cost, including the cost of feeds, labor, the use of building and fences, interest on the value of capital stock, depreciation, insurance, repairs and the use of land amounted to ₱116.39 for the Nagoya lot and ₱105.59 for the Los Baños Cantonese lot. That the expense incurred in the Nagoya lot was greater than in the Los Baños Cantonese lot was due to the interest and insurance on the value of the capital stock, as the 30 Nagoya hens were valued at ₱180.00 and the 30 Los Baños Cantonese hens at only ₱90.00, obviously, the profit in the Nagoya lot is less than in the Los Baños Cantonese lot. Subtracting the total expenses from the returns from the sale of eggs, it is seen that the Nagoya lot gained ₱0.70 or 0.6 per cent on the total investment and the Los Baños Cantonese lot gained ₱11.40 or 10.79 per cent. The value of manure was not taken into consideration as no record was kept of the amount produced. These results conclusively show that under the conditions of this experiment, the Los Baños Cantonese breed was more profitable than the Nagoya.

It cost 41.6 centavos to produce a dozen eggs in the Nagoya lot and 34.0 centavos in the Los Baños Cantonese lot. These figures clearly show that the Los Baños Cantonese pen produced eggs a little more economically than the Nagoya pen. On an average, the Los Baños Cantonese lot required 2.57 kgm. of feeds consisting of both mash and grain to produce a dozen eggs; the Nagoya lot required 2.91 kgm.

It is interesting to note that in the study conducted by Fronda and Paje (1930), the average amount of feeds consisting of both grain and mash required by the Los Baños Cantonese pullet to produce a dozen eggs was 2.6 kgm. By using the actual expenses incurred these writers reported that with the Los Baños Cantonese pullets the average cost of producing a dozen eggs was 38.8 centavos.

Under the conditions of the present study, the cost of producing a dozen eggs was less than that reported by Fronda and Paje. The difference was due to the fact that at the time they conducted their experiment the cost of a kilogram of feed was ₱0.09, while the cost of a kilogram of feed in the present study was only ₱0.056. Furthermore, the cost of labor at that time was higher than it is at present.

Mortality

Table 5 shows the percentage of mortality of the birds in the two lots. Referring to this table it may be seen that six Nagoya hens and four Los Baños Cantonese hens died during the year. It may be also noted that five birds in the Nagoya lot were stolen on June 7, 1932. However, this loss was not considered as mortality in this study.

Two Nagoya hens were choked by the doors of the trap nests. and two died of egg bound as determined after a post-mortem examination. The eggs that were taken from the oviducts of these birds were of regular size but the birds were not able to expel them. The other two birds died on December 13, 1931. The causes of the deaths were not determined. Basing the computation of the percentage of mortality on the total number of birds in the pen, it was found that the Nagoya lot had 20.0 per cent mortality which was considered rather high.

Four birds died in the Los Baños Cantonese pen. Bird 1557 died in September and bird 1529 in October. The causes of the death of these birds were not determined. Bird 1593 died on February 2, 1932. She was broody for a long time and as a result she decreased considerably in weight and finally died. The other bird died in June, 1932. If the percentage of mortality is based on the total number of birds in the pen, the Los Baños Cantonese pen had 13.3 per cent mortality.

In general, the birds in the two lots increased in body weight. The increase made by the Nagoya lot was 398.4 grams or 25.9 per cent of the initial body weight, while that of the Los Baños Cantonese lot was only 231.1 grams or 16.7 per cent of the initial body weight. The increase in the body weight was due to the increase in the size of the body and the deposit of fat.

Incubation results

Table 6 gives the percentage of fertility and hatchability of the eggs set from the two lots. The averages of the three hatches made

were used in the computation. It was found that 89.3 per cent of the Nagoya eggs set were fertile and only 71.8 per cent of the Los Baños Cantonese.

It may be observed by reference to this table that 47.5 per cent of the Nagoya eggs set were hatched, and only 36.0 per cent of the Los Baños Cantonese. These percentages of hatchability were based on the total number of eggs set. If based on fertile eggs only, 53.2 per cent of the Nagoya eggs hatched, and only 47.0 per cent of the Los Baños Cantonese.

Taking the average of the initial weights of the chicks in the three trials, it was observed that a Nagoya chick weighed 30.1 grams and the Los Baños Cantonese chick, 27.6 grams. This difference was to be expected because the Nagoya chicks were hatched from larger and heavier eggs than the Los Baños Cantonese. The larger and the heavier the egg, the larger the chick it will produce. Tioaquen (1933) also reported that on an average the Nagoya chicks were heavier than the Los Baños Cantonese.

From unpublished data in the files of the Poultry Division, it was found that the average weight of the chicks hatched from the Nagoya eggs imported from Japan in 1926 was 39.46 grams. It will be noted that this weight is very much greater than the average weight of the chicks hatched from the Nagoya eggs in this study. These differences were to be expected because the 1926 chicks were hatched from selected Nagoya eggs. The average weight of the imported eggs was 62.0 grams which was considered extra heavy. The eggs set in this study were selected at random from the Nagoya eggs laid during the first laying year. The effect of the new environment may also have had some influence on the decrease in the size of the Nagoya egg.

SUMMARY OF CONCLUSIONS

The results of a study on the comparative economy of egg production of the Los Baños Cantonese and the Nagoya breeds of fowls are here reported.

1. It was observed that in the Nagoya lot the birds averaged 134.8 eggs and in the Los Baños Cantonese lot, 136.0 eggs. But, if only the egg production of the birds that completed the year is considered, the average egg production per bird in the Nagoya lot would be 131.5 eggs and that in the Los Baños Cantonese lot, 134.6 eggs.

2. Of the 3356 eggs laid by the Nagoya lot, 45.83 per cent were standard; and of the 3726 eggs laid by the Los Baños Cantonese lot, only 13.98 per cent were standard.

3. Basing the computation on the present selling price of eggs, ₱117.09 was realized from the sale of the Nagoya eggs produced during the year and ₱116.99 from the sale of Los Baños Cantonese eggs.

4. The Nagoya lot consumed 814.3 kgm. of feeds costing ₱45.62 and the Los Baños Cantonese lot consumed 799 kgm. of feeds costing ₱44.72. The average consumption of a Nagoya hen was 32.7 kgm. of feeds costing ₱1.84; of a Los Baños Cantonese hen, 29.1 kgm. of feeds costing ₱1.63. When based on a kilogram live weight, the average feed consumption per bird was 19.27 kgm. of feeds costing ₱1.08 for the Nagoya lot, and 19.28 kgm. of feeds costing ₱1.08 for the Los Baños Cantonese lot.

5. The total expenses incurred, including the cost of feeds, labor, use of building and fences, interest on capital stock, depreciation, insurance, repairs and the use of land was ₱116.39 for the Nagoya lot and ₱105.59 for the Los Baños Cantonese lot.

6. The average cost of producing a dozen Nagoya eggs was 41.6 centavos, of a dozen Los Baños Cantonese eggs, 34.0 centavos.

7. Deducting the total expenses from the amount received from the sale of eggs, the net returns in the Nagoya lot was ₱0.70 or 0.6 per cent on the total investment: in the Los Baños Cantonese lot it was ₱11.40 or 10.79 per cent on the total investment.

8. The percentage of mortality in the Nagoya lot was 20.0 per cent, and only 13.3 per cent in the Los Baños Cantonese lot.

9. The average percentage of fertility of the eggs set was 89.3 per cent in the Nagoya lot and only 71.8 per cent in the Los Baños Cantonese lot. The average percentage of hatchability of the total eggs set was 47.5 per cent in the Nagoya lot and 36.0 per cent in the Los Baños Cantonese lot.

10. The average initial weight of the Nagoya chick was observed to be 30.1 grams; of the Los Baños Cantonese chick, 27.6 grams.

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TABLE 1

Showing the percentage of monthly egg production of the Nagoya lot and of the Los Baños Cantonese lot

MONTHS	BREEDS	
	Nagoya	Cantonese
	per cent	*per cent*
September	32.8	44.8
October	32.5	31.3
November	36.3	38.1
December	39.1	37.5
January	49.8	50.1
February	46.6	43.9
March	45.3	44.3
April	37.6	35.9
May	32.4	32.3
June	31.9	29.8
July	26.3	26.3
August	27.6	26.4
Average	36.5	36.7

TABLE 2

Showing the number and value of eggs produced in the Nagoya lot and the Los Baños Cantonese lot

MONTHS	BREEDS							
	Nagoya				Cantonese			
	Standard [a]	Undergrades [b]	Total	Value	Standard	Undergrades	Total	Value
	number	*number*	*number*	*pesos*	*number*	*number*	*number*	*pesos*
September ..	110	185	295	9.95	19	376	395	12.04
October	165	137	302	10.71	27	253	280	8.67
November ...	159	163	322	11.25	20	300	320	9.80
December ...	195	135	330	11.85	32	294	326	10.10
January	177	225	402	13.83	44	399	443	13.73
February ...	90	257	347	11.31	17	328	345	10.52
March	136	211	347	11.77	65	306	371	11.78
April	110	161	271	9.23	69	222	291	9.42
May	109	132	241	8.32	34	237	277	8.47
June	132	48	180	6.72	57	182	239	7.74
July	135	20	155	6.00	35	197	232	7.31
August	123	41	164	6.15	102	111	213	7.41
Total	1641	1715	3356	117.09	521	3205	3726	116.99
Average per bird [c]			134.8	4.69			136.0	4.24

[a] Standard egg (45 grams and up) at ₱0.04 each.
[b] Undergrade (44 grams and below) at ₱0.03 each.
[c] Total number of birds, 24.9 for the Nagoya lot and 27.4 for the Cantonese lot.

TABLE 3

Showing the amount and cost of feeds consumed by the Nagoya lot and by the Los Baños Cantonese lot

MONTHS	BREEDS							
	Nagoya				Cantonese			
	Mash [a]	Grains [b]	Total	Value	Mash	Grains	Total	Value
	kgm.	*kgm.*	*kgm.*	*pesos*	*kgm.*	*kgm.*	*kgm.*	*pesos*
September ..	39.5	44.0	83.5	4.64	39.0	42.0	81.0	4.52
October	36.0	31.0	67.0	3.79	31.0	28.0	59.0	3.32
November ...	44.5	39.0	83.5	4.72	37.5	38.0	75.5	4.22
December ...	32.5	41.0	73.5	4.05	31.0	40.0	71.0	3.90
January	44.0	33.5	77.5	4.43	44.0	33.0	77.0	4.40
February ...	35.5	40.0	75.5	4.19	35.5	40.5	76.5	4.22
March	30.5	30.0	60.5	3.39	31.0	31.0	62.0	3.47
April	32.0	29.5	61.5	3.47	31.0	29.0	60.0	3.37
May	29.5	44.5	64.0	4.03	30.0	34.0	64.0	3.55
June	32.3	19.8	52.0	3.02	25.0	22.5	47.5	2.68
July	26.0	26.4	52.4	2.93	32.8	35.6	68.5	3.81
August	25.5	27.8	53.3	2.96	30.2	27.4	57.6	3.25
Total	407.8	406.5	814.3	45.62	398.0	401.0	799.0	44.72
Average per bird [c]	16.4	16.3	32.7	1.84	14.5	14.6	29.1	1.63

[a] Mash mixture at ₱0.064 a kilogram.
[b] Grain mixture at ₱0.048 a kilogram.
[c] Total number of birds, 24.9 in Nagoya lot and 27.4 in Cantonese lot.

TABLE 4

Returns over the total expenses incurred (including the cost of feeds and capital charges) and the total cost of producing a dozen eggs

	Nagoya		Cantonese	
	pesos	*per cent*	*pesos*	*per cent*
Value of eggs produced	117.09	—	116.99	—
Total cost of feeds consumed	45.62	—	44.72	—
Returns above the cost of feeds	71.47	—	72.27	—
Percentage returns	—	61.03	—	61.8
Total expenses (including capital charges and cost of feeds)	116.39	—	105.59	—
Net returns above total expenses	0.70	—	11.40	—
Percentage net returns	—	0.60	—	10.79
Total cost of producing one dozen eggs	0.416	—	0.34	—

TABLE 5

Showing the number and weights of the birds at the beginning and at the end of the experiment

ITEMS	BREEDS	
	Nagoya	Cantonese
Number of birds at the beginning, September 1, 1931	30	30
Average weight of the birds at the beginning	1536.8 grams	1383.3 grams
Number of birds at the close, August 31, 1932	19 [a]	26
Average weight of the birds at the close	1935.2 grams	1614.4 grams
Average increase in weight	398.4 grams	231.1 grams
Percentage of increase	25.9	16.7
Number of birds that died during the year	6	4
Percentage mortality during the year	20.0	13.3

[a] Five birds were stolen on June 7, 1932.

TABLE 6

Showing the percentage of fertility and hatchability of the eggs set in each of the two lots [a]

OBSERVATIONS	BREEDS	
	Nagoya	Cantonese
Number of eggs set	210	210
Percentage of infertiles [b]	10.7	28.2
Percentage of D_1 [c]	8.3	6.2
Percentage of D_2 [d]	6.2	9.3
Percentage of D_3 [e]	27.3	20.3
Percentage hatched	47.5	36.0
Average initial weight of chicks in grams	30.1	27.6

[a] Average of the three hatches were used.
[b] Infertile eggs.
[c] Eggs with dead embryo after the first week.
[d] Eggs with dead embryo after the second week.
[e] Eggs with dead embryo after the third week.

A STUDY OF COCONUT SEEDLINGS IN RELATION TO SHAPE OF THE NUTS [1]

FELICISIMO S. MACEDA

WITH TWO TEXT FIGURES

The study of coconut seedlings in relation to shape of the nuts is a fundamental problem in coconut production. It is important to determine the relation, if any, between the shape of the nuts and the agronomic characters of the seedlings that grow from them. If such a relation could be established it should prove valuable in the improvement of coconut plantations, especially large ones.

Some experiments have been made in connection with coconut seeds and seedlings. Blackman (1919) stated that the food stored in the seeds is the factor mainly responsible for the weight of seedlings and that the annual growth of a plant, at least in its early stages, follows approximately the "Compound Interest Law."

Lacson (1921) and Novero (1922), in their studies of the "size and shape of coconuts as indicators of their meat content" found that orbicular, ellipsoid, obovoid and oblong nuts had a smaller amount of meat than round nuts and that with equal volume of unhusked nuts, the nuts from type A (round nuts) contained more meat than those from any other type. These investigators recommended round nuts for seed because the products of round nuts are the most desirable for copra production. Under each type a large unhusked nut is an index of a correspondingly large amount of meat. These authors further reported that other types possess relatively thicker husks.

Munro and Brown (1920) claim that "the seed should be selected from trees which are bearing well at the time of collection and from those which, by previous statistics, show that they have for a considerable period given consistently good average yearly crops; preference being given to the nuts of fair size and of a rounded shape. Very large nuts and those of a particular oblong shape are better to

[1] Thesis presented for graduation, 1933, with the degree of Bachelor of Science in Agriculture from the College of Agriculture, No. 367; Experiment Station contribution No. 913; Prepared in the Department of Agronomy under the direction of Dr. Pedro A. David and Mr. Teofilo F. Novero.

be avoided, as in the former case there will, as a rule, be few nuts on the spathe, and in the latter they will not usually contain so much meat in the kernel as rounded nuts."

Sampson (1923), reports that "on the Malabar coast the long nut is generally considered to be the best for copra, but in many other countries the round nut is preferred."

The purpose of the present experiments was to find out the differences between round and oblong nuts as to average number of days and percentage of germination; average growth of seedlings; average number of leaves developed; average weight of seedlings; average number of roots developed; average length of the roots. So far as the author knows this is the first report on the study of coconut seedlings in relation to the shape of the nuts from which they grew.

MATERIALS AND METHODS

Nuts of two shapes were used in this study, the round and the oblong. The term round, as applied to the nuts, means that the polar and the equatorial circumferences of the fruit are equal or almost equal. The term, oblong, means that the length of the nut is greater than its width.

A week before planting, five hundred nuts of each shape were secured from the barrio of Pagsawitan, Santa Cruz, Laguna. They were taken from one lot. The mother trees from which the nuts were gathered range in age from 40 to 45 years. In gathering the nuts care was taken not to allow them to fall to the ground. A man climbed the tree, picked the matured nuts and with a long rope slowly lowered them to the ground. Those nuts which accidentally fell in being lowered were discarded. It took two days for ten men to gather 1000 nuts. The nuts were brought from Santa Cruz to the College of Agriculture nursery in a truck.

After the nuts had been gathered they were classified. Five hundred round nuts of approximately the same size were selected. The size was determined by the water displacement method. A gasoline can was provided with a spout on the side and then filled with water to the level of the spout. Each nut was then immersed in the water and pushed below the surface with an iron tripod. The water that was displaced ran out through the spout into a graduated cylinder which recorded its volume and thus gave the size of the nut which displaced the water. Five hundred oblong nuts were selected and measured in the same manner.

Two seed beds, one for the round and one for the oblong nuts were made by digging the ground to about 30 centimeters in depth and then pulverizing the soil. On the same date the nuts were planted in rows, 30 centimeters apart, buried to about two-thirds of their size in a slightly oblique position with the acute end downward and the germinating eye near the upper surface. The nut was placed in an oblique position because, as only two-thirds of the nut is buried, it would have more surface area exposed to the ground and the supply of water to the embryo would be moderate. (See figures 1 and 2.) Sampson (1923) made a study on the coconut fruit and its development. According to him, "if the fruit be examined, it will be found that one side is narrower than the other two. If the nut be examined it will be found that one segment has a wider angle than the other two and that the center of this widest segment is opposite the angle formed by the two widest faces of the fruit. It is this widest segment which has the soft or germinating eye."

The seeds were watered twice a week during the summer months. Each lot received the same amount of water. No watering was done after the rainy season started. The beds were weeded occasionally. All other subsequent treatments given to the lots were similar in application and nature.

EXPERIMENTS AND RESULTS

In the present study, oblong and round nuts of practically the same size, as measured by water displacement method, were used. The measurements of the 500 oblong and the 500 round nuts studied are given in table 1.

During the period of the experiment, only 468 oblong and 447 round nuts germinated. These nuts were studied to determine whether the shape of the nut has any influence on its germination. The nuts in each group were observed daily in the field at practically the same hour and the exact number of days from planting to germination for each was recorded. As a rule, the seedlings in each group appeared quite healthy and all developed normally. (See figures 1 and 2.) Statistical analysis of the data obtained was made. The results are presented in table 2.

The percentage of germination of 468 oblong and 447 round nuts was determined. After the daily examinations of the dates of germination in each group, the actual daily percentage of nuts germinated was calculated. The results of these observations are shown in table 3.

Twelve months from the date of planting, the average length of the leaves of each seedling was carefully measured. In this study, there were 462 seedlings grown from oblong nuts, and 440 seedlings from round nuts. The mean length of the leaves and standard deviation for each group were determined. The results of these determinations are presented in table 4.

In the studies on the number of leaves on the seedlings the number of leaves developed in each seedling under each group was counted. Table 5 gives the mean number of leaves and standard deviation of the seedlings from the 462 oblong and from the 440 round nuts.

Fig. 1.—Showing oblong nut seedlings after 336 days.

The nuts of the two different shapes were compared as to the weights of the seedlings developed from them. Each seedling was dug up, great care being taken not to cut any part of its roots. All the soil clinging to the roots was carefully removed. Then each seedling was weighed. All the seedlings were weighed on the same day. The results of the measurements as analyzed are presented in table 6.

The number of roots per seedling was determined in the field when the weight was taken. Long and short roots on each seedling were combined to give the total number of roots for that seedling. Table 7 shows the results of the statistical analysis of the data obtained.

After the nuts were weighed and their roots counted, the length of all roots on each seedling was measured. The average length of the roots on each individual seedling was taken as the root length for that particular seedling. The results are recorded in table 8.

DISCUSSION OF RESULTS

Volume of nuts

As shown in table 1, the seed nuts used, taken as a whole, were of practically the same size, as measured by water displacement method. The mean difference in volume between the two types of nuts was 1.20 ± 0.59 cubic centimeters. This difference is insignificant.

Number of days from planting to germination

Table 2 shows the frequency distributions, means and standard deviations for the number of days from planting to germination for nuts of each shape. The most interesting fact observed in this table is the earliness of germination of round nuts as compared with that of oblong nuts. The mean difference between the round and oblong nuts in the number of days required for germination was 2.65 ± 0.60. The significant difference may be explained by the fact that round nuts have thinner husks than nuts of any other shape. Lacson (1921) and Novero (1922) reported that nuts of type A (rounded nuts) have a thinner husk than the nuts of any other shape. It is assumed that the thin husk of round nuts offers little resistance to the emergence of the tips of the shoots, although there were a few round nuts which developed some deformed shoots. The results suggest that the round nuts are to be preferred for seeds when early germination is desired.

Percentage of germination

As shown in table 3, the oblong and round nuts gave 93.6 and 89.4 total per cent germination, respectively. The difference between the two types of nuts in the percentage of germination was only 2.42 ± 1.53 per cent. This is an insignificant difference. It may also be noted that the greatest number of nuts of both types germinated after 47.5 days from planting. Some of the nuts of the two types failed to germinate. These were attacked by brown ants (*Pheidologiton diversees* Jordan) and termites (*Macrotermes gilvus* Hogen). The round and the oblong nuts were equally susceptible to these pests.

Length of leaves

The statistical analysis of the data on length of leaves of the seedlings produced from round and from oblong nuts is given in table 4. As shown by the means the seedlings from the two types of nuts produced practically the same length of leaves. No significant difference was found in the standard deviations in the round and the oblong nuts. These results seem to indicate that round and oblong nuts of nearly the same size have the same ability to carry on leaf development. (See fig. 1 and 2.)

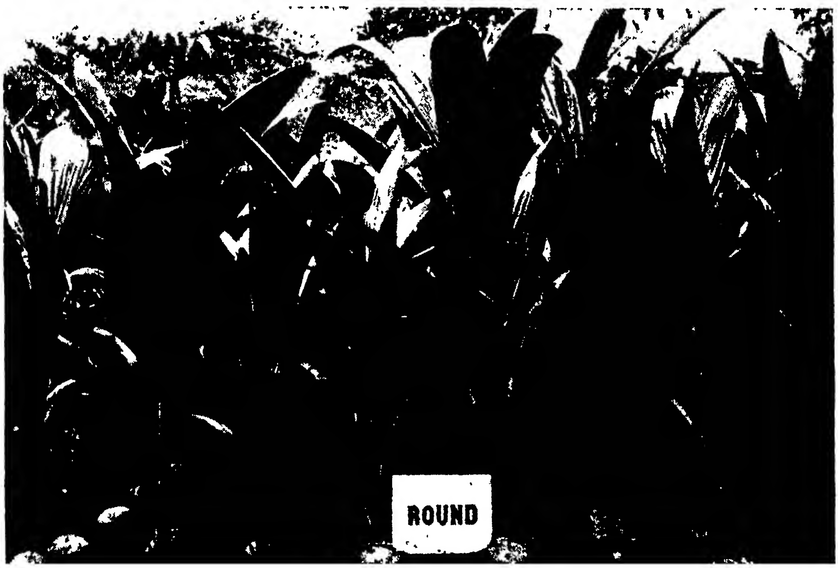

Fig. 2.—Showing round nut seedlings after 336 days.

Number of leaves

The mean number of leaves of the seedlings from the two shapes of nuts is presented in table 5. Comparing the means of the two types of nuts it is shown that seedlings from round nuts had a greater number of leaves than seedlings from oblong nuts. A mean difference of 0.53 ± 0.04 leaf was found. This difference is small but still considered statistically significant. There is some evidence of a difference in the number of leaves produced by seedlings from round and from oblong nuts in favor of the round nuts. This difference may be explained by the fact that round nuts contain more endosperm than oblong nuts of the same size. This work was reported by Lacson and Novero in their studies on the "size and shape of coconut as

indicators of its meat content." Of 462 seedlings from oblong nuts, 216, or nearly 50 per cent produced seven leaves twelve months after planting in the nursery. Of 440 seedlings from round nuts, 159, produced seven leaves. In the number of leaves produced, the seedlings from round nuts were found to be more variable than those from oblong nuts.

Weight of seedlings

In this experiment it was found that the mean weight of seedlings from oblong nuts was 2.77 $\pm$ 0.001 kilograms and from round nuts, 2.85 $\pm$ 0.002 kilograms. The difference between these means is 0.08 $\pm$ 0.002 kilogram which is significant. (See table 6.) The standard deviations show that there was a slight difference in favor of the round nuts. The round nuts were more variable, as shown in table 4. Blackman (1919), reports that the "Compound Interest Law" is applicable to some extent to the growth of higher plants. "The plant is continually unfolding its leaves and increasing its assimilating power. Successive increase in the weight of the plant can not therefore be treated as a discontinuous geometric series, as if the new material (interest) were added to the end of the daily or weekly periods. New material is added continuously during daylight, and during rapid growth the plant is continuously, or almost continuously, unfolding its leaves and increasing its assimilating rate. The growth of the plant more nearly approximates money accumulating at compound interest where the interest is added continuously." Blackman further states that the food stored in the seeds is the factor mainly responsible for the weight of seedlings. The data show that seedlings from round nuts were on the average heavier than the seedlings from oblong nuts (see table 6). The results suggest that with nuts of the same size round nuts are preferable for planting.

Number of roots

It may be noted in table 7 that the seedlings of round nuts have a greater number of roots than the seedlings of oblong nuts. The difference between the means is 1.30 $\pm$ 0.16, which is significant. No significant difference was found between standard deviations for number of roots of the round and oblong nuts. Copeland (1921) reports that "the young part of the root immediately behind the cap is covered by a very delicate epidermis; it is through this that the root absorbs water and the mineral food dissolved in the water." It may be added that as a general proposition the more roots the seedlings have the more vigorous they will prove to be.

Length of roots

Referring to table 8 it may be seen that the length of roots from both types of nuts was practically the same. No significant differences were found in the standard deviations in the two types of nuts. It may be stated, therefore, that the length of roots is not influenced by the shape of nuts studied.

SUMMARY AND CONCLUSIONS

The investigations here reported deal with the relation between certain characters of coconut seedlings and shape of the nuts which produced them. The data on hand obtained from 1000 individual nuts of Laguna type and 902 seedlings seem sufficient to warrant the establishment of the following generalizations:

1. With equal volume, round nuts germinated earlier than the oblong nuts.
2. No difference in percentage of germination between oblong and round nuts was found.
3. The length of leaves of coconut seedlings is not influenced by the shape of the nuts.
4. The seedlings from the round nuts produced more leaves than seedlings from the oblong nuts.
5. The seedlings from round nuts were heavier than the seedlings from oblong nuts.
6. The seedlings from round nuts produced a greater number of roots than those from oblong nuts.
7. The length of roots of seedlings did not depend upon the type of nut used.

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TABLE 1

Comparison of frequency distributions, means and standard deviations for the volume of oblong and round nuts

TYPES	CLASS CENTERS IN CUBIC CENTIMETERS						TOTAL	MEAN	STANDARD DEVIATION
	3257.5	3267.5	3277.5	3287.5	3297.5	3307.5			
								cc.	*cc.*
Oblong	84	98	116	102	94	6	500	3278.34 ± 0.42	13.87 ± 0.30
Round	88	120	105	100	83	4	500	3277.14 ± 0.41	13.71 ± 0.29
Difference								1.20 ± 0.59	0.16 ± 0.42

TABLE 2

Comparison of frequency distributions, means and standard deviations for the number of days from planting to germination of oblong and round nuts

TYPES	CLASS CENTERS IN DAYS											TOTAL	MEAN	STANDARD DEVIATION
	27.5	37.5	47.5	57.5	67.5	77.5	87.5	97.5	107.5	117.5	127.5			
													days	*days*
Oblong	16	64	150	95	95	27	12	5	2	1	1	468	55.41 ± 0.36	15.02 ± 0.24
Round	30	62	167	90	59	19	11	6	3	0	0	447	52.76 ± 0.48	14.88 ± 0.34
Difference													2.65 ± 0.60	0.14 ± 0.42

TABLE 3

Comparison of frequency distributions, means and standard deviations for the percentage of germination of oblong and round nuts

TYPES	CLASS CENTERS IN DAYS												TOTAL	MEAN	STANDARD DEVIATION
	27.5	37.5	47.5	57.5	67.5	77.5	87.5	97.5	107.5	117.5	127.5	137.5			
														per cent	*per cent*
Oblong	3.2	13.2	29.8	19.2	18.4	5.8	2.2	.8	.4	.2	.2	.2	93.6	55.49±1.07	15.37±0.76
Round	5.8	12.4	33.4	18.2	11.0	4.2	2.4	1.0	.8	.0	.2	.0	89.4	53.07±1.09	15.26±0.77
Difference														2.42±1.53	0.11±1.08

TABLE 4

Comparison of frequency distributions, means and standard deviations for the length of leaves of seedlings from oblong and round nuts

TYPES	CLASS CENTERS IN CENTIMETERS												TOTAL	MEAN	STANDARD DEVIATION
	22.05	46.05	70.05	94.05	118 05	142.05	166.05	190.05	214.05	238.05	262.05	286.05			
														cm.	*cm.*
Oblong	4	6	11	12	44	76	114	108	63	24	0	0	462	166.46±1.31	41.86±0.93
Round	3	3	5	19	42	68	85	111	68	22	10	4	440	172.10±1.42	44.04±1.00
Difference														5.64±1.93	2.18±1.37

TABLE 5

Comparison of frequency distributions, means and standard deviation for the number of leaves of seedlings from oblong and round nuts

TYPES	CLASS CENTERS IN NUMBER OF LEAVES								TOTAL	MEAN	STANDARD DEVIATION
	4	5	6	7	8	9	10	11			
										leaves	*leaves*
Oblong	4	19	94	216	115	12	2	0	462	7.00 ± 0.03	0.84 ± 0.02
Round	0	7	53	159	154	57	9	1	440	7.53 ± 0.03	1.00 ± 0.02
Difference										0.53 ± 0.04	0.16 ± 0.03

TABLE 6

Comparison of frequency distributions, means and standard deviations for the weights of seedlings from oblong and round nuts

TYPES	CLASS CENTERS IN KILOGRAMS								TOTAL	MEAN	STANDARD DEVIATION
	1.3	1.8	2.3	2.8	3.3	3.8	4.3	4.8			
										kgm.	*kgm.*
Oblong	6	39	120	160	96	28	12	1	462	2.77 ± 0.001	0.03 ± 0.001
Round	2	51	108	151	88	48	11	1	440	2.85 ± 0.002	0.06 ± 0.001
Difference										0.08 ± 0.002	0.03 ± 0.001

TABLE 7

Comparison of frequency distributions, means and standard deviations of roots of seedlings from oblong and round nuts

TYPES	CLASS CENTERS IN NUMBER OF ROOTS								TOTAL	MEAN	STANDARD DEVIATION
	1	4	7	10	13	16	19	22			
										roots	*roots*
Oblong	2	17	94	136	114	75	22	2	462	10.33 ± 0.12	3.78 ± 0.08
Round	1	13	63	152	115	75	18	3	440	11.63 ± 0.12	3.67 ± 0.08
Difference										1.30 ± 0.16	0.11 ± 0.11

TABLE 8

Comparison of frequency distributions, means and standard deviations for the length of roots of seedlings from oblong and round nuts

TYPES	CLASS CENTERS IN CENTIMETERS											TOTAL	MEAN	STANDARD DEVIATION
	12.5	18.5	24.5	30.5	36.5	42.5	48.5	54.5	60.5	66.5	72.5			
													cm.	*cm.*
Oblong	9	36	78	122	121	69	19	6	1	0	1	462	32.77 ± 0.27	8.71 ± 0.19
Round	11	40	84	129	100	51	19	6	0	0	0	440	31.67 ± 0.28	8.56 ± 0.29
Difference													1.10 ± 0.39	0.15 ± 0.28

ABSTRACT [1]

A further study of nitrification in the Philippine soils. VICENTE B. ARAGON. *(Thesis presented for graduation, 1918, with the degree of Bachelor of Agriculture from the College of Agriculture No. 368; Experiment Station contribution No. 914.)*—The main object of this work was to make a further study of nitrification in some Philippine soils. Five samples of soil taken from different parts of the College Farm and four nitrogen foods, ammonium sulfate, dried blood, horse manure and waste molasses were used in the experiment. The rate of nitrification on different soils in the same nitrogen foods was determined. The effects of aëration, calcium carbonate, double superphosphate, kainite, moisture content of the soil and calcium oxide upon the rate of nitrification of the nitrogen foods used were also determined. The "beaker method" was used in the preparation of the soil culture, and the phenoldisulfonic acid (colorimetric) method for the determination of the rate of nitrification.

The author found that in all the five samples of the soil treated the percentage of nitrogen nitrified was highest in ammonium sulfate (33.20 per cent); second highest in dried blood (22.24 per cent); lowest in horse manure (1.26 per cent); there was no apparent nitrification in waste molasses. In the samples to which sand freed from carbonates was added in the proportion of one to two, the rates of nitrification were higher than in the samples where the proportion added was one to three. In the samples where calcium carbonate was added, the rate of nitrification increased with increase of weight of calcium added, the increase being proportionately much greater in horse manure than in dried blood. In soil B, taken from a field which had been planted to different kinds of legumes and at the time of sampling was planted to rice, and D, nursery soil where different ornamentals had been planted, the rate of nitrification was decreased with increase in the amount of magnesium carbonate in horse manure, dried blood and waste molasses. A mixture, however, of equal amounts of calcium and magnesium carbonates increased the rate of nitrification in horse manure, dried blood and molasses when three grams of the mixture were added to the sample treated. The addi-

[1] Abstract prepared as part of the required theme work in English 3a, College of Agriculture.

tion of 40 milligrams of double superphosphate to every 100 grams of soil decreased the rate of nitrification in horse manure, dried blood and waste molasses. The addition of kainite to the soil samples also decreased the amount of nitrate nitrogen, the decrease ranging from 23 per cent to 79 per cent. Before adding the molasses to the soil, the addition of 1.5 to 2.5 grams of calcium oxide to one gram increased its nitrification to about 3.95 per cent in the samples treated.

The author arrived at the following conclusions:

1. Soils that had been growing one crop continuously for some time gave a lower rate of nitrification than the soils where the crop had been varied.

2. Ammonium sulfate was nitrified at a rate about 50 per cent greater than dried blood.

3. Application of calcium carbonate at the rate of 15 tons to the hectare practically doubled the rate of nitrification.

4. In the case of waste molasses to which five grams of calcium carbonate had been added, the addition of one and one half grams of magnesium carbonate brought an increase of about 100 per cent in the amount of nitrites that accumulated in the soil.

5. The application of sand or other materials which would tend to make the soil loose is beneficial to nitrification.

6. Kainite like double superphosphate and magnesium carbonate when applied alone in the soil interfered with the rate of nitrification.

Abstract by Porfirio R. Manacop

CURRENT NOTES

The second floating exposition, like the one held last year, had for its main object to help popularize articles of Philippine manufacture or origin. To accomplish this object, Philippine manufacturers were invited to send their products to the exposition not only for demonstration but also for sale....

Twenty-two ports located in sixteen provinces of Mindanao, the Visayan Islands, and the Bicol region were visited by the exposition. The cruise lasted twenty-two days. During that time, sales amounting to ₱24,050.19 were made, or more than twice the amount sold during the first exposition....

Forty-two new trade connections, consisting mostly of agents or manufacturers' representatives appointed to act as distributors, were actually established during the last trip. Many more applied for agency connections but their requests could not be acted upon

for lack of authority from the manufacturers to appoint them as agents. The manufacturers and dealers concerned will be duly informed of these requests....

A manufacturer of slippers in Batangas, who personally went with the second floating exposition, and whose articles were among the fastest sellers in the whole show, established fifteen agencies for the distribution of his products while traveling with the exposition.

Philippine Journal of Commerce, June, 1933

Oranges should have an important place in the diet. Although a flavour fruit which stimulates the appetite, the orange has an actual nutriment value of 240 calories to the pound, due principally to its high sugar content. This fruit sugar, which is an energy-giving food, is in a form easily digested and assimilated by the body. In addition, the orange contains a small quantity of protein, the muscle-building food element, and a high proportion of valuable mineral salts and acids. These minerals are particularly important, since they are not found in some of the foods of which we commonly eat large quantities such as meat, white rice, potatoes, white bread and sugar.

While known as acid fruits, oranges are often prescribed in cases of acidity. This is due to the fact that these fruits have an alkaline reaction after digestion, and thereby counteract acidity. Orange juice is rich in vitamins, important factors in the prevention of disease and regulation of body processes. Orange juice should form a regular part of the diet of young babies, to supplement the vitamin deficiency sometimes found in milk, making a complete and perfect food for the young child.

Farming in South Africa, May, 1933

The production of margarine and soap in Great Britain is dependent upon supplies of suitable oils and fats which are not home produced. It is, however, satisfactory to know that the Empire is able to supply a considerable proportion of the raw materials required by these industries. The Empire now produces 65 per cent. of the palm oil, 60 per cent. of the copra, 59 per cent. of the sesame seed, 58 per cent. of the palm kernels, and nearly one half of the groundnuts consumed throughout the world. Omitting large quantities of soya beans grown and used in China, and of cotton seed in the United States, the Dominions and Colonies provide more than one half of the world's oilseeds and nuts....

The manufacture of margarine has become a very important industry in Britain, some five million cwts. being produced per annum. It is now accepted as a high-grade foodstuff, and special products of the largest manufacturing organization have been available for some years with a vitamin content equal to that of the best summer butter. The relative absence of vitamins A and D from ordinary margarine is perhaps the most serious criticism that can be levelled against its use to replace butter. Not only has this difficulty been overcome, but an advance of some importance appears to have been made in margarine. It is based on the discovery that the characteristic aroma of freshly made butter is due, in the main, to the presence of an extremely small proportion of diacetyl.

Tropical Agriculture, (Trinidad, B. W. I.) July, 1933

The United Kingdom drinks six times as much tea as it drinks coffee, while the United States drinks sixteen times as much coffee as tea. South Africa leans distinctly to coffee, Canada has a slight preference for tea, while Australia is definitely a tea drinking country.

Agriculture and Live-stock in India, May, 1933

COLLEGE AND ALUMNI NOTES

The Laguna Fair Association met at the College of Agriculture in the morning of August 29. Acting Dean Mendiola was invited to attend the meeting and the luncheon in Molawin Hall.

This association which is duly incorporated held a provincial fair in May, 1924 on the College of Agriculture Campus. The Association has at present a fund of more than ₱900 which it wants to dispose of or invest in a worth while undertaking. For this purpose, a committee of three, consisting of Mr. E. Barreto, chairman, Mr. A. B. Latham, representing the Calamba Sugar Estate, and Prof. I. Elayda as members, was appointed to study this matter. Acting Dean Mendiola made a plea for our Baker Memorial Fund for the support of the deserving self-supporting senior students in this College.

In a letter to the Dean of this College Mr. L. de Los Santos of Balasan, Iloilo requests information as to availability of two graduates in Agriculture, one to manage a property consisting of 16,000

coconut trees, all productive, 40 hectares of rice land, and 150 hectares of fishponds all completely constructed; and one to take charge of hog, poultry, and duck projects carried on a large scale and also a soap factory.

Mr. H. V. Costenoble, a farmer of San Juan, Malitbog, Leyte, in a letter to Prof. N. B. Mendiola dated September 1, writes of some of the problems he is at present meeting. Excerpts from Mr. Costenoble's letter follow:

> I have let a long time pass by before answering your letter of June 7th because I wanted to let you know the results of the seeds you did send me. The coffee germinated splendidly and I am now transplanting it into the permanent positions. The Gloria bananas both are also growing fine. The pepper seeds, however, are somewhat under your estimate—about twelve would come up you thought—but only five have came to life. If it is possible for you to send me some more I would be very grateful.
>
> Of the materials you wished me to send you I am sending today the suckers of that navel pineapple. I wished to give you some more but could not find out for certain which plants produced the navel fruits, they had been harvested before I got your letter. Only one plant was undoubtedly of that variety so I am sending you its suckers.
>
> The cacao is not ripe yet; as soon as it is ready I shall send you fruits of it.
>
> Soybeans I believe will not do well here, it is too wet for them. Two varieties I had planted produced seeds but they were all shrunken and did not germinate. It is hard to even grow mungos here; we have practically only two months to plant them, January and February. Any other time they do not produce any full seeds. I have taken to *sitao* and *seguidillas* therefore which grow practically all the year round and produce something eatable and saleable at the same time.
>
> I am highly satisfied with the climate here which is really the best I have yet found anywhere in the Philippines but one trouble is the low price of our products, abaca and copra, and the other, the abundance of pests, namely, locusts and rats. I have given up planting rice and corn on their account and produce in my fields only camote, mungos, tobacco, ube, cassava, etc.
>
> These are not eaten by the locusts and not too much damaged by the rats.....

The eighty-fifth regular scientific meeting of the Los Baños Biological Club was held in the Lecture Hall of the Poultry Building, College of Agriculture, in the evening of August 24, 1933.

The following papers were read and discussed:

"Protein supplements in poultry rations: I. Comparative studies of the effects of shrimp meal, meat scraps, tankage and fish meal as supplements in rations for growing chicks."

By Dr. F. M. Fronda, Mr. Juan S. Padilla
and Mr. Acelo C. Badelles.
Paper read by Doctor Fronda.

"Shrinkage in Philippine Woods."

By Mr. Calixto Mabesa.

"Blight of Cinchona seedlings."

By Mr. M. S. Celino.

The following is quoted from *Tropical Life* June, 1933 number.

In the *Philippine Agriculturist* for March, pp. 665-676 are very wisely given up to a study of "A Brown Bark Rot of the Trunk of the Cacao Tree," by Sres. G. O. Ocfemia and Martin S. Celino of the local Department of Plant Pathology. When the trouble was discovered in November, 1930, the excised portions of the diseased cacao trunk were brought to the Plant Pathology Institute, and isolations were made. These yielded a *Fusarium* which produced a perfect stage, the characteristics of which belonged to the genus Nectria .... One of the most conspicuous effects of the disease is the stimulation of the plants so that they produce an enormous number of flowers. Many fruits are formed from these flowers but they do not mature. When they reach the size of two to five centimeters they begin to wilt and shrivel, and then soon die. The dead fruits persist on the branches and trunk of the tree. On the other hand, infected trees begin to shed the greater portion of their leaves. The newly-formed leaves are smaller than those produced before the trees are infected. When all the leaves have fallen off, the bare branches begin to die, starting at the tips.

All this may be new to the Philippines, but is it new elsewhere? Die-back is, of course, an old enemy, and maybe a different trouble to the above. We shall be glad to hear reports on the matter from other centres, for whether with cacao or other crops, the tendency is for pests rather than profits to rule the roost and that of course must be stopped.

Dr. Robert L. Pendleton, head Department of Soils spent part of August and September in Mindanao. He accompanied Dr. E. B. Copeland, technical adviser in Bureau of Plant Industry. Special object was some investigational work in Cotabato. This is a commendable effort in coöperation between this College and the Bureau of Plant Industry.

Mr. Juan Padilla, B.Agr. '32 (Baker Scholar), at present in charge of the Trinidad Poultry Farm in Baguio, owned by Mrs. J. J. Elizade was a Campus visitor on August 24-25. Mr. Padilla brought

from this farm two pens of 13 hens each which he entered in the Third Egg Laying Contest conducted by the Poultry Division. One pen is Rhode Island Reds and the other White Leghorns. According to Mr. Padilla, the climate in Baguio is excellent for temperate breeds of chickens. The Mikawa, a Japanese breed is also raised on the Trinidad Farm. The Trinidad Poultry Farm covers an area of about 4 hectares and has about 3,000 chickens, 1000 of which are laying hens.

Not a single chicken was lost in the recent epidemic of fowl cholera in Baguio. We may add, Mr. Padilla is far too modest to so claim, that this clean bill of health is largely due to Mr. Padilla's ability as a poultryman and far more to his industry in maintaining strict sanitation.

Mr. Padilla joined the benedicts last April.

Mr. Pedro S. Paje, '27, second assistant superintendent in the Iwahig Penal Colony, wrote Mr. V. B. Aragon of the Department of Agronomy asking for some definite information on certain phases of lowland rice culture such as the control of pests; the names, days of maturity, and average yields per hectare of some lowland rice varieties now being grown commercially in the Philippines; some factors affecting the tillering habits of lowland rice plants; the advantages or disadvantages of maintaining water in lowland rice paddies throughout the entire growing season; etc.

Lieutenant Nemesio A. Catalan B.S.A. '20 was a recent Campus visitor. Lieutenant Catalan who deserted agriculture for the army some ten years or more ago has just returned from the United States where he was in the school for officers at Ft. Sill, Oklahoma, specializing in motors and other mechanical lines. Lieutenant Catalan was the first instructor in Military Science in the College of Agriculture. He is now stationed at Camp Stotsenberg.

Mr. Thuan Komkris B.S.A. '33 writes Professor Yule that as an employee of the Department of Agriculture, Siam he will be assistant supervisor in the Experiment Station at Kuan Nieng (near Singora, South Siam). Mr. Thongdee Resananda B.S.A. '24 is supervisor of the station. Mr. Resananda now bears the title Luang Suvanwahjakgasigy a free translation of which is "Sir Speaker of

Golden words on Agriculture". Mr. Komkris writes that Roem Purnariksha B.S.A. '28 is on the teaching staff of the Agricultural school associated with this station. Also, Swasdi Viradeja B.S.A. '32, Charas Sundarasinha B.S.A. '28, Sankvien Tulalamba a former College student, who was graduated last June from Iowa State College of Agriculture are employed in the Experiment Station and Agricultural School at Korat, Central Siam. Mr. Iang Chandrastitya B.S.A. '21 is supervisor of this station and school. Mr. Chandrastitya is now Luang Inka Srikasikarn, which very freely translated is "Sir Wise in Agriculture". Charoon Suebsaeng B.S.A. '28 is at Kon Kaen, East Siam. It is gratifying to know that these, our graduates, are having the opportunity to put to use in the much needed agricultural development of Siam, the training and knowledge they received in this College. Mr. Komkris writes of his longing for College friends and the Campus "which had become a home to me!"

Dr. Tomas V. Rigor, formerly assistant in the Department of Agricultural Chemistry of this College and at present Farm Adviser in the Culion Leper Colony, wrote the Department of Agronomy requesting information on the agronomic descriptions of some native and foreign sugar cane varieties grown in the Philippines.

The first convocation under the auspices of the U. P. Student Council was held in Baker Memorial Hall, August 31. The principal speakers were Ex-Speaker Manuel Roxas, Hon. Arsenio Bonifacio and Hon. Feliciano Gomez, Representatives from Laguna. Mr. Dennis Molintas, College representative in U. P. Council presided. Dr. M. Manresa and Mr. Ramon Enriquez, president, U. P. Student Council introduced the speakers.

Domingo Anioay, B.S.A. '32, reports that he is now employed as temporary insular teacher in Central Luzon Agricultural School, Muñoz, Nueva Ecija. He is teaching four sections in horticulture and two sections in general science.

Mr. Albino Jison of Silay, Occ. Negros and Dr. Maximo Borromeo of Cebu, Cebu bought from the College of Agriculture in August cassava graters manufactured by the Department of Agronomy.

The Mimics was host at a party at which the Associated Women Students were the favored guests in the evening of September 15. The party was given in rooms of Department of English. Dancing and games and much youthful gayety made the evening a merry one.

IN MEMORIAM

CIPRIANO BARBON, B.Agr. '26
Farmer, Oriental Misamis, 1926—33
Provincial Hospital, Cagayan, Oriental Misamis, July 29, 1933

THE SOCIETY FOR THE ADVANCEMENT OF RESEARCH[1]

F. M. FRONDA

Secretary, Society for the Advancement of Research

The Society for the Advancement of Research was organized to encourage original investigation in pure as well as applied sciences. It is a scientific honorary society, the charter members of which are all members of the Sigma Xi, an honorary scientific fraternity in the United States. The original plan was to organize a Sigma Xi chapter in the Islands to which new members might be elected. Because of certain difficulties that would have to be surmounted, the original plan was given up and instead a society, different in name but with aims similar to those of the Sigma Xi, was formed.

The Sigma Xi Club which formed the nucleus of this Society was organized on September 11, 1928. The Society for the Advancement of Research, however, was not formally organized until two years later, September 10, 1930. The constitution and by-laws of this society are modeled after those of the Sigma Xi, and similar standards for the election of new members were also adopted.[2]

Membership in the Society is of two kinds, active and associate. The active members are the charter members; those who may be elected to active membership by the Society; and other members of the Sigma Xi residing in other parts of the Islands who have become active members by application and payment of dues. The associate members are senior students in the Associated Colleges at Los Baños who have been elected by the Society. Only students who show originality and promise of ability in scientific investigation and who have high scholastic records may be elected as associate members of the Society.

The Society started with an original membership of eleven active members. Since its organization, three became active members by affiliation and seven were elected to active membership by the Society. To date, the Society has ten associate members. Thus,

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[1] General contribution from the College of Agriculture No. 364.

[2] *See* also FRONDA, F. M. 1931. History of the Society for the Advancement of Research. Proceedings of the Society for the Advancement of Research 1 (No. 1): 1–3.

the Society for the Advancement of Research now has twenty-one active and ten associate members. A directory of the Society follows this article.

The officers of the Society are a president, a vice-president, a secretary and a treasurer. The president and vice-president are elected annually and the secretary and treasurer, every three years. The officers of the Society for the first year were:

President—Mr. N. B. Mendiola
Vice-President—Dr. R. L. Pendleton
Secretary—Dr. F. M. Fronda
Treasurer—Dr. José B. Juliano

By action of the Society on July 11, 1931, the election of officers that year was postponed till March 11, 1932. In this election, Dr. L. B. Uichanco was elected president and Dr. A. K. Gomez, vice-president. Doctors Fronda and Juliano continued as secretary and as treasurer, respectively, for another year. In the election of officers held on March 23, 1933, the following officers were elected:

President—Dr. G. O. Ocfemia
Vice-President—Dr. Miguel Manresa
Secretary—Dr. F. M. Fronda
Treasurer—Dr. Leon G. Gonzalez

The Society for the Advancement of Research has presented five public programs. The inaugural program was on September 17, 1931. A complete report of this meeting was published in the Proceedings of the Society.[3] The second public program of the Society was on November 14, 1931; Professor L. R. Jones of the University of Wisconsin was the guest of honor and principal speaker. A summary of his address entitled "Disease Resistance in Plants" is published elsewhere in this issue of THE PHILIPPINE AGRICULTURIST.

The third program was on August 4, 1932. The guest of honor and principal speaker was Doctor E. B. Copeland, founder and first dean of the College of Agriculture. Doctor N. B. Mendiola, past president of the Society, in introducing Doctor Copeland spoke as follows:

In previous gatherings and assemblies which our guest of honor has addressed he has been introduced in several important capacities. He has been introduced as the founder of the College of Agriculture of the University of the Philippines. He has been introduced also as the first dean of the same

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[3] *See* Proceedings of the Society for the Advancement of Research 1 (No. 1) November, 1931.

college. Mention must have been made of his being a former botanist of the Philippine Government and author of several books on Philippine agriculture. Important as these capacities are and while together with other attainments they show how versatile and learned the man is, for me, these are not as interesting as the rôles in which I prefer to introduce him to you tonight. I desire to introduce him to you in his rôles which are most inspiring and which are of immediate interest to our Society and these are as a man of science and as an active research man. Being a member of the faculty of this College, I happen to know something about its fortunes and misfortunes, and I sometimes wonder what kind of a college of agriculture ours would have been, if as its founder and first builder, Doctor Copeland were not a scientist and had allowed his scientific judgment of the Filipinos to be affected by the very unscientific prejudice against their race. As it happened he was one of those responsible for the breaking of the barrier of prejudice against Filipino scientific capacity. One of his significant acts in this connection was the sending of graduates of this College to the United States for post-graduate work, in the face of criticism from those belonging to the so-called white race, and placing of great scientific responsibility on their shoulders upon their return.

In the early days of this College when those who now compose the Society for the Advancement of Research were comparatively unschooled in science, it was not as easy for me as it is now to understand the cause of Doctor Copeland's scientific attitude and the effect of this on his daily acts. It seems to me he could not help but have the scientific regard for daily things if he was and is always active in research. A man of this attitude is a constant source of inspiration. It is for this reason coupled with a brilliant literary style that the writings of our guest of honor, his addresses and conversation fascinate his readers or his listeners.

In the scientific world Doctor Copeland is better known as a fern specialist than as a worker with other plants. I believe he is the world's authority on Indo-Malayan ferns. Tonight he is giving a Los Baños audience a privilege which I do not remember he has ever given before. This evening he will tell us a few things about his work with ferns.[4] I am therefore very happy to introduce to you Doctor Copeland, not the founder or the first dean of this College, but Doctor Copeland the research man, and member of the Society of the Sigma Xi.

A scientific program was presented on March 23, 1933 in connection with the initiation of new active members that year. On this occasion, Dr. N. B. Mendiola presented an illustrated paper entitled "A Method of Plant Improvement Based on Production through Injury of Heritable Variations." This paper appears in this issue of the College journal, THE PHILIPPINE AGRICULTURIST. The fifth public program that was sponsored by the Society was given on October 26, 1933. This evening, the Reverend Miguel Selga, S. J., Director

[4] Parts of this lecture were later published by Doctor Copeland under the title "Trichomanes", in the Philippine Journal of Science 51: 119–280. *Pl. 1–61.* 1933.

deal, of course, rests on the interpretation of what constitutes research. Indiscriminate and perhaps superficial gathering of an assortment of data without any attempt made at rearranging the facts in order to draw relevant conclusions is not research in a scientific sense. "There's a vast difference," says Lorimer, "between having a carload of miscellaneous facts sloshing around loose in your head and getting all mixed up in transit, and carrying the same assortment properly boxed and crated for convenient handling and immediate delivery." Large funds to draw from, and expensive equipments, although admittedly a great help in the hands of the right individuals are not a prime essential to the pursuit of scientific investigation. There is a minimum point, however, in which a scientific laboratory can be maintained without seriously impairing its efficiency. Especially in these days of financial retrenchment, there has been an increasing feeling that research centers maintained through public subsidy must limit their activities to projects that will have immediate practical application. Soviet Russia, for instance, is reported to have placed a ban on the pursuit of science for purely intellectual gratification as being anti-social. The idea, on the face of it, cannot but appeal as a strongly commendable attitude; for why waste funds and effort on gazing at stars and counting chromosomes when depleted coffers need immediate rehabilitation? There is, however, one serious hitch in the adoption of this policy, and that is the fact that, strictly speaking, the distinction between applied science and pure science is largely illusory. It is generally admitted that there is only one kind of science, and that is the so-called pure science; so that what we commonly term applied science is but application of pure science. Any curtailment of activities to mere application may not only lead to reducing scientific men of our country to a state of stagnation but also to drying up the basic source of productive work.

The vast, unexploited field for research in the Philippines has been repeatedly pointed out. A visiting scientist coming into this country for the first time usually, after a few days of field work, waxes enthusiastic over its rich opportunities. The magnitude of problems, however, and the versatility of situations that one encounters at every corner in his work not infrequently has at times an overwhelming effect, so that a beginner, especially, soon faces the danger of finding himself lost in a maze of details. Scientific work, like other creative pursuits, is necessarily individualistic. Efforts

in the past at harnessing groups of scientific men together into a single working unit have resulted in standardized mediocrity. But resistance to organization in scientific research does not imply an alternative of individual isolation. Stimulating contacts with fellow workers must be maintained whereby as colleagues they may discuss their problems, share in each other's success, and even profit by each other's mistakes. Coöperation is a bilateral relationship and is not without its parallel in the biological relationship of other living organisms. The mutual help extended need not always be in the form of bouquets; for constructive criticism, given and taken in the proper spirit, has done more for the advancement of scientific knowledge than all the volumes of eulogy. Personal aspersions are not constructive criticisms and have no place in scientific discussions. The author may be proved to be suffering from certain physical or even mental defects; but the impartial reader judges the work on its intrinsic merits. Honesty, more than in any other branch of human activity, is a fundamental requirement in scientific work. Half truths, distortion of facts, except where unwittingly committed owing to errors in interpretation, appropriation of another person's data or of his intellectual products without giving proper credit—these are not in keeping with high scientific standards and the perpetrator when found out soon loses caste among his fellow workers.

Before concluding, I would like to point out one other matter: Contemporary scientific literature has grown so enormously in extent in recent times that the investigator working in a particular field very seldom finds the inclination to delve further into older writings. By ignoring them he deprives himself of perhaps an important clue to the solution of his problems. The attitude of mind of deprecating an old paper or an old idea merely because it is old is in effect an abdication of one of the most important prerogatives of mankind which has placed him at an advantage over other animals, and that is his ability to profit by the experience of his predecessors. Taking an extreme case, we know that no modern astronomer, with his instruments of precision and more advanced scientific knowledge, has been able to calculate the annual movements of the sun and the moon with the same accuracy as the Chaldean Kidinnu, 400 years before Christ, the difference being due to the fact that the latter had before him 360 years of lunar observations on which to base his conclusions while our contemporaries have not such data (Breasted, Science 74: 643. 1931). During the Spanish régime, a certain

amount of scientific work was done in the Philippines and published either by resident or by visiting workers. In addition, there was a large mass of printed data, particularly from the pens of priests, as Fray Gaspar de San Agustin, Martinez de Zuñiga, Aduarte, Juan de Placensia, Chirino, Colin, Murrillo y Velarde, and Delgado, which while not strictly of a scientific nature are a prolific source of important data for certain branches of science as applied to the Philippines. To the average scientist, these records are a closed book but they need not remain permanently so, for they contain a mine of useful information on matters which sometimes are just what we require for the proper pursuit of our work.

DISEASE RESISTANCE IN PLANTS [1]

L. R. JONES
Professor of Plant Pathology, University of Wisconsin

In the address that I delivered before the Los Baños Biological Club last evening I called attention to the importance of plants as experimental subjects, touching on the cell theory and the discovery of protoplasm. I also spoke of the work of the German mycologist, Anton de Bary on the causal relation of fungi to disease in plants. I discussed the researches of the Russian botanist, Woronin on cellular pathology; that is, the interaction between the cytoplasm of the host and the cytoplasm of the parasite. In discussing parasitism and disease in plants I mentioned the importance of the fungi as causal agents of plant maladies and that these were later on followed by the bacteria; also, that the virus diseases are becoming increasingly important as studies on them are being made.

For a proper understanding of disease in plants it is necessary to know what a normal plant is. A plant in health is in a state of equilibrium inside with outside conditions. Diseases cause a disturbance of the equilibrium in nature.

BIOLOGICAL EQUILIBRIUM

In nature, plant and animal life are in a state of equilibrium. The predominance of one over the other disturbs this equilibrium. As examples of this disturbed equilibrium may be mentioned the following: In Australia, a species of cactus was introduced as a pot plant. Later, the plant escaped cultivation and was increasing so prodigiously that it threatened to cover the land with impenetrable spiny-plant covering. To control the very rapid spread of the cactus it was necessary to introduce into Australia the following enemies of the cactus: (1) A caterpillar which bores tunnels through the plant; (2) a plant bug and (3) a cochineal insect which sucks the

[1] Notes prepared by G. O. Ocfemia from an address delivered by Professor L. R. Jones of the University of Wisconsin when he was a guest of honor at the annual meeting of the Society for the Advancement of Research held in the College of Agriculture Auditorium on November 14, 1931. Doctor Ocfemia assumes full responsibility for errors in statements and interpretations made in these notes.

General contribution from the College of Agriculture No. 366.

juice of the plant and (4) a mite which scratches the surface of the plant.

In Hawaii the sugar cane industry was threatened with destruction by weevils and the use of parasites saved the industry. The introduction into Hawaii of the Minah bird for combating insect pests of the sugar cane; the work in the Philippines of the entomologists of the Hawaiian Sugar Planters' Association to secure parasites of insects attacking sugar cane in Hawaii are instances of activities to restore disturbed equilibrium. Other instances which may be mentioned are the control in Kenya Colony of the mealy bugs of coffee with the use of the lady-bird and the control with a parasitic fly of the coconut moth, whose caterpillar destroyed the leaves of the palms in the Fiji Islands. In plant pathology, equilibrium has a different biological basis from that with insects and parasites.

In the introduction of a new crop in a new country at least three easily definable factors are involved.

(1) Adaptation of the crop plant to the new environment.

(2) Presence of potential new parasites.

(3) Relative susceptibility or resistance of plant to parasites.

A knowledge of these factors is very important especially in new cultures in the Philippines.

DISEASE RESISTANCE

The control of plant diseases by the production of highly resistant varieties, strains or individuals through breeding and selection consists of changing the nature of the plant in such a way that it is no longer susceptible to a given disease or pathogen. The production of resistant plants will probably be the ultimate solution of plant-disease control problems.

Disease resistance is not a new idea with us. The work on disease resistance at Wisconsin has been done by members of the staff, especially Dr. J. C. Walker and students.

Illustrations of disease resistance may be seen from the history of plant pathology in Europe and America. Take grape diseases and European grapes versus American grapes. There are many varieties of these grapes and they have many parasites. A universal resistance to destruction occurs among these grapes.

A generation ago, American grapes were introduced into Europe because the American roots are resistant to *Phylloxera*. In Europe the American grape was almost completely wiped out by the downy mildew and only the discovery of Bordeaux mixture saved the industry. Now, in Europe the use of spray for the control of the

mildew is widespread. It is possible to get resistant vines by hybridization but because spraying is practical the work for production of resistant plants has never been finished.

European potato breeding obtained relative resistance which could be maintained by skillful attention to source of seed and cultivation of the plants in the field. Unlike the work on grape mildew no spray that offers better advantages for the control of the disease than by breeding resistant plants is used in potato.

BREEDING FOR DISEASE RESISTANCE IN THE UNITED STATES

Norton in 1913 published the results of his work on breeding asparagus for resistance against the rust, *Puccinia asparagi* DC. The occurrence of the rust on asparagus in the United States was discovered in 1896. About 1902 the disease was prevalent and destructive wherever asparagus was grown. As different strains varied in their susceptibility to the rust, breeding was started as a means of controlling the disease. Norton's work showed that structural differences were the cause of resistance to rust in the asparagus and that vigor of the plants was not necessarily correlated with resistance. It became necessary for growers and breeders of asparagus to adopt methods for satisfactorily keeping out the disease from the fields and follow pedigree breeding work or the production of resistant strains.

On bean diseases, breeding for disease resistance has resulted in the production of the variety Robust against the bean mosaic and Red Kidney against the anthracnose.

WISCONSIN WORK WITH CABBAGE

Dr. J. C. Walker has been engaged on plant-breeding work for ten years. In his work, Doctor Walker found pure line for resistance and susceptibility. According to him disease resistance is a single factor which is dominant.

Of the work with other Fusarium-wilt diseases may be mentioned that on peas by Linford (1928) who describes varieties resistant to the disease.

Cabbage yellows

Cabbage yellows is caused by the fungus *Fusarium conglutinans* Wollenw. The fungus attacks the roots of cabbage in the seed bed or within a short time after transplanting. The infected plants are

stunted and the leaves become pale and then yellow. The cabbage may be uniformly attacked or the disease may first appear on one side with the result that a curving of the stem and leaves may follow. Infection begins with the fibrous roots. From the roots the fungus passes to the stem tissues where it may first be noted in the vascular bundles. The vascular bundles first become water-soaked in appearance. Then they become darker colored and finally assume brownish black. The cortical tissues lying over these bundles gradually die and collapse. The infection of the root and stem of the cabbage causes reduction of the supply of water and food materials from the soil. The fungus continues invading the upper parts of the plants. As soon as this takes place the plants begin to shed their lower leaves. The cabbage may be killed in a week or so after transplanting although some may live for a month or more. Less severely infected cabbages may live through the summer without production of heads.

In badly infected soils in southeastern Wisconsin the loss ranges from 50 to 95 per cent.

The development of cabbage yellows is favored by high soil temperature. The disease is worst when a period of dry hot weather prevails after the young plants are set in the field. Once *Fusarium conglutinans* is introduced into a soil it persists indefinitely so that even crop rotation does not affect the disease that it produces.

The disease cannot be controlled by treatment of cabbage seed, seedlings and soil. Steam sterilization is effective but the application of this is restricted to seed bed.

Cabbage yellows can be controlled only by the use of resistant varieties or strains.

In Wisconsin the standard winter varieties of the Hollander or Ball Head type are the ones suited to commercial cultivation, but these are very susceptible to the yellows. Selections were made from sound heads in the worst diseased fields in the autumn. Seeds were raised from these sound heads and the seedlings from these were grown in badly infected soil. The sound plants which were left were saved as source of seed.

By repeated selection, strains of the winter cabbage of the Hollander type were secured. These have proved highly resistant against the cabbage yellows besides possessing the best commercial qualities. The best selected head strain, VIIIa 25, compared with the commercial susceptible strain behaved as shown in the following table.

TABLE 1

Wisconsin Hollander cabbage; second generation selections

PERCENTAGE DISEASED	PERCENTAGE LIVING	PERCENTAGE OF HEADS	AV. WT. OF HEADS IN POUNDS	YIELD IN TONS PER ACRE
Commercial, Ferry 81	46	24.5	2.65	2.1
Resistant, VIIIa 251.5	100	98.0	5.45	18.8

NATURE OF DISEASE RESISTANCE

There are several bases of resistance in plants. Only two of these may be mentioned in this connection. Conant (1927) working on the black root rot of tobacco caused by *Thielavia basicola* Zopf. found that there is a close correlation between the histology of the roots of tobacco and resistance to the parasite. The tips of the roots and the elongating region are highly resistant to the disease, perhaps because the fungus cannot penetrate the epidermis. Further back from the region of elongation the epidermis is broken when the activity of the cambium is in progress. As no cork is present in this region the tobacco roots are very susceptible. *Thielavia basicola* is unable to penetrate cork. As soon as the roots begin to lay cork on the walls of their cells the tobacco is no longer susceptible to infection.

In the smudge of onion, Walker (1923) noted that although the volatile oil of the onion has a retarding effect upon germination and growth of the fungus *Colletotrichum circinans* a substance closely associated or identical with the red and yellow pigments is apparently the chief factor causing resistance to smudge infection.

It has been shown in the onion that the color of the bulb determines the relation to the disease. Red has been found to be resistant, yellow, resistant, but white, susceptible. The question has been raised: Is it anthocyanin or some associated elements that is responsible for this resistance? They have found associated with the colored scales of the onion derivatives of phenol. They have isolated protocatechic. In the cabbage what is the substance to which resistance is due?

Link and Bailey (1926) working on *Fusarium* species which cause bulb rot of onions first in the field and after harvest in transit and storage found that red, yellow and white varieties are equally susceptible. These fungi readily produce decay when inoculated into wounds of onion bulbs.

APPLICATION TO PHILIPPINE PROBLEMS

The knowledge of disease resistance of plants has very important applications to Philippine problems. The question of the control of banana wilt, cabbage wilt, cabbage black leg, a disease which is now present in the region around Baguio, tomato, sugar cane mosaic, pineapple diseases, and diseases of new crops depends on isolation of varieties or strains which are highly resistant. In the United States the tomato industry is only possible in many sections by disease resistance.

Of course, in addition to the question of disease resistance for the control of plant diseases, it is supplementary to guard against introduction of the disease, contamination of the soil, seed treatment and spraying, important cultural conditions and careful selection of environment to suit crops.

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A METHOD OF PLANT IMPROVEMENT BASED ON THE USE OF HIDDEN HERITABLE BUD VARIATIONS AND THOSE PRODUCED THROUGH INJURY [1]

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WITH EIGHT TEXT FIGURES

INTRODUCTION

It is well known that the improvement of plants is based on heritable variations. Methods of plant improvement vary. In the last analysis, however, all methods of plant breeding consist fundamentally in the selection of certain mother plants for propagation purposes from a group of varying individuals. These methods differ only in details and as regards the variations involved.

In a sense we can say that the variations on which selection methods have been based so far are natural, exposed variations. These may be classified into four groups:

1. Variations already in existence in groups of plants. This group may be subdivided into:
    a. Natural species which are products of natural evolution
    b. Seminal mutations
    c. Natural hybrids
    d. Bud sports unintentionally propagated
2. Variations produced by artificial crossing.
3. Variations produced by seed propagation without previous inbreeding of mother plants which are ordinarily propagated vegetatively. Seed propagation gives a chance for the effects of hidden factor mutations and chromosomal variations to come out.
4. Variations produced by inbreeding which gives a chance for the effects of hidden heterozygosities to manifest themselves.

In the future a new kind of variations is bound to enter into our work of plant improvement and to add new methods to our systems of plant breeding. These variations may be called artificial variations. For example, an attempt is now being made to produce

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new variations by treatment with X-rays. This has been done with sugar cane, maize, barley, oats, wheat (Stadler, 1930); cotton (Horlacher and Killough, 1931); and tobacco (Goodspeed, 1930); radium rays have been used on *Datura* (Gager and Blakeslee, 1927); chloral hydrate solution, on *Phaseolus vulgaris* (Hofmann, 1927), and on other plants by other plant breeders. There are experiments, also, in which low and high temperatures and low and high light intensities have been tried as agents.

In this paper I am suggesting a new method of plant breeding. I have formulated this method after many years of experience with numerous varieties of plants. The method makes use of hidden and artificial variations. These variations consist either of (1) latent heritable variations, that is those already initiated in plants but lying dormant and only to be released by stimulated shoot production and vegetative propagation, and (2) those to be initiated by injury caused by mutilation, wounding, or by vegetative propagation itself as by cuttage and by graftage and by exposure to unfavorable environment.

LATENT HERITABLE VARIATIONS. DO THEY EXIST

We can not deny that new heritable variations are being initiated in the cells of the plant. Whether they are initiated owing to certain inherent tendencies in the germ cell or to external influences or to both is immaterial in the present discussion. Neither is it necessary to inquire here how the new variations are shown,—whether by factor mutations, by chemical or cytoplasmic variations, or by what are called saltations. The important thing is that such variations originate in the plant and that in plant improvement it is important that these variations are given a chance to manifest themselves. I have already pointed out that propagation by seed is a method of giving such a chance in plants propagated vegetatively. Variations produced in this way are called seminal variations. There are, however, certain variations which appear vegetatively and which we usually call bud sports. Heretofore, we have been content to wait for them to appear. No attempt has even been made as a regular method of plant improvement to produce them artificially and increase our materials for selection. Why should we not give such variations as have been initiated already but are unable to manifest themselves vegetatively, a chance to appear? Or if they will appear, why should we not hasten their appearance? If we do this for seminal variations, there is no reason why we should not for bud variations.

If we bear in mind that in a multicellular plant, the type to which most of our agricultural plants belong, all the cells come originally by successive divisions from the zygote, that many cells have not lost the power of regeneration, that in fact many of them are destined to develop into dormant vegetative buds, branches, and stems, and that in the millions and millions of cases of cell divisions which take place in the development of a plant many irregularities in chromosome divisions or pairing or even gene mutations may occur, then it is not difficult to imagine that in any plant there must be the initiations of heritable variations which ordinarily remain latent until an opportunity comes for them to manifest themselves. For many cells capable of regeneration, no such opportunity ever comes. If the cells mature or die or if the plants containing them die before this opportunity arrives then these latent variations die with them.

We know from the results of breeding experiments and seed propagation that certain changes taking place in the germ cells give rise by seed propagation to new varieties or even new species. This being the case we should expect that similar changes are taking place in cells which never become seed germs but become vegetative buds actually or potentially. To such changes are due the numerous cases of bud sports which have been reported by many observers over a long period of time. There is reason to believe that such changes are as frequent as those manifested sexually. Speaking, for example, of tetraploid species, Jorgensen (1928) says that he can not agree that most species exhibiting double chromosome numbers are hybrids and that he considers that tetraploidy induced in the somatic tissue much more widespread than the gametic duplications. Also, Stout (1915), comparing variations obtained by vegetative propagation of *Coleus* with those obtained by seed propagation of the same parents found that in this genus asexual and sexual reproductions are not fundamentally different in respect to the extent and range of variation.

Assuming that the initiation of variations within the cells of a plant are shown in changes in the number and structure of chromosomes, we should find within a plant variability among the cells in these respects if our assumption of the existence of latent variations in the cells is correct. This variability we might call intracellular chromosome variability. There seem to have been no systematic studies made to determine to what extent such variability exists within an individual plant. What evidence we have in this connection is derived from cytological studies done for other pur-

poses. However, such studies have resulted in showing the existence of such a variability. To cite a few instances: Hance (1918) reported that within a plant of *Oenothera scintillans*, the somatic chromosome number varied from 15 to 21, that this variation existed throughout the same plant and that the percentage of the different classes of variants was approximately the same for the three generations studied. According to Dr. José Capinpin of this College, L. L. Burlingame of Leland Stanford University reported in the Cleveland meeting of the A. A. A. S., December, 1930, which Doctor Capinpin attended, that in *Clarkia*, the number of chromosomes in somatic cells varies in the plant from 6 to 12. Condit (1933) determined the chromosome number of 31 species of *Ficus*. He found that the diploid number in each of these species is 26 but in a single cell of meristematic tissue of *F. pumila minima* he found a tetraploid number. He also reported that in an earlier study he found a polyploid and euploid condition in the endosperm cells of *F. carica* and *F. palmata*.

One cause of variability in number of chromosomes is either non-disjunction or doubling of chromosomes. Mol (1923) reported occasional doubling of chromosome number in *Hyacinthus orientalis* and attributed the phenomenon to the physiological effects of premature harvesting or cutting off the leaves. Mol (1926) also reported somatic variations in tulips and narcissi with or without change in chromosome number. Blackburn and Harrison (1924) found that in *Rosa tomentosa* the microspores carry 7 chromosomes in the nuclei, while in the egg cells, 28. Longley (1927) made a study of the number of chromosomes in several old and well established varieties of *Zea mays*. The diploid number found was usually 20. However, he found plants with a somatic number of more than 20 chromosomes in six varieties. Kostoff (1930) reported that in one root tip of a *Nicotiana* hybrid, he found that the cells of one-half of the root had 20 chromosomes, and the other half had 40. This is called chromosomal chimera. According to Kostoff chromosomal chimera has been observed by himself in other *Nicotiana* back-crosses and reported by other authors in tomato and *Crepis*. McClintock (1929) has reported this in a case of an F_2 maize. In a plant there were found both 2n and 2n-1 cells. The occurrence of polyploid cells in the tissue of normal diploid plants has been reported as a regular feature in a number of species, among which are *Spinacia oleracea* (reported by De Litardiere, 1923), *Cannabis sativa* (De Litardiere, 1924 and Breslawetz, 1926, 1932), sorghum species (Huskin and Smith, 1932) and *Acer platanoides* (Mewman, 1933). Somatic cells containing diploid

and polyploid chromosome numbers have been discovered in *mercurialis annua* (De Litardiere, 1924), *Solanum lycopersicum* (Mann Lesley, 1925), *Melandrium album* (Breslawetz, 1926) and *Cucumis sativus* (Koschuchow, 1928).

It would be highly interesting and instructive if we could map out the consistent occurrence of this variability for each variety of every species. A map of a plant showing chromosomes variability would furnish a breeder, using the method suggested in this paper, a guide in the stimulation of shoot production, would tell him where to mutilate or wound a plant so as to cause the development of buds located in the regions where the varying cells are found.

Having discussed the existence of latent heritable variations in plant cells, I shall now explain *how these latent heritable variations, particularly in somatic cells, could be released.*

If in a plant there are cells in which gene or chromosome changes have taken place and these cells are capable of developing into vegetative buds and shoots, variations due to these chromosome changes could be released by allowing dormant buds to develop by cultural methods or by using such horticultural treatments as we now use, such as pruning, wounding, ringing and girdling. The stimulation of shoot production is already a regular practice in the propagation of hybrids by grafting or budding. It is done, however, with no thought of releasing hidden variations. Parent hybrid plants are propagated vegetatively to avoid seminal segregations. And in the case of the original Kawisari B coffee plant and the original mother plants of the different Para rubber clons in Java, Sumatra, and other countries, the parent hybrid plants had been pruned severely and intermittently in order to induce the production of shoots which later on were cut to become sources of buds for budding on numerous stock plants. It is likely that if we made it a regular practice to induce a plant to produce shoots at parts where ordinarily they do not produce them we should be witnessing the appearance of bud sports, which otherwise would never appear, and be enabled to carry on bud selection where we have not been able to do so. More will be said on this subject in the discussion of the suggested new method of plant breeding.

ARTIFICIAL INITIATION OF HERITABLE SOMATIC VARIATIONS

In this paper I am using the term "somatic variation" as synonymous with bud variation," or "vegetative variation" and "somatic

cells" with "vegetative cells," therefore it is not intended that they should exclude cases in which the germ tract as well as the soma is involved.

The method of improvement suggested in this paper calls for the artificial initiation of heritable somatic variations, similar to the initiation of heritable germinal variations, by injuring the plants. We can not depend exclusively on chance variations in somatic cells. They might be very few after all. Hence we should, if possible, cause variations to be initiated and then released for use of the breeder.

It is possible that there are several agents which may be used in the production of these variations in somatic cells, such as mechanical injury and radical changes in environmental factors like temperature, pressure, light intensity, and irradiation. In this paper, however, it is mainly mechanical injury that will be considered.

FIELD OBSERVATIONS SUGGESTING INITIATION OF VARIATIONS BY INJURY

Injury due to vegetative propagation and pruning. In a number of papers on variations published in the years 1919 to 1932 (1919, 1922a, 1922b, 1923, 1926a, 1926b, 1927, 1928, 1929, 1931, 1932), I reported many instances of somatic or bud sports which I had encountered while engaged in the culture and study of many species and varieties of plants. In a paper which was read for me by Doctor Capinpin before the First Philippine Science Convention and an abstract of which was published recently (Mendiola, 1932) a summary list of these bud sports numbering 39 separate cases, was presented. In speculating then about the cause or causes of these variations I suggested the possibility that mutilation was a cause of bud sporting in many of them. I pointed out the significance of the fact that the 39 cases of bud sports reported consisted of 14 species and that a majority of these 14; namely, sugar cane, cassava, banana, pineapple, hibiscus, sarasa, croton, gardenia, and papua, are propagated vegetatively, that is, by process involving mutilation. In one case of variation, that of the change of sex expression in *Carica papaya* as a result of decapitation, the change can be produced many times artificially.

The suggestion of the possibility that mutilation is a cause of bud sporting in many plants has led me to study to what extent injury to plants has been found a factor in the production of heritable variations. A survey of pertinent literature has resulted in confirming my opinion and in the discovery that injury in fact has been used in the artificial production of chromosome changes.

Injuries may be inflicted on an organism in various ways, either by mutilation or by wounding without involving severance of parts. The mutilation or wounding may be either by artificial or by natural agents.

Referring to cultivated plants mutilation is involved in certain regular practices such as pruning, propagation by cutting, by graftage, and by marcottage. In nature, injury is inflicted by numerous plant enemies, fungi, insects, and other animals and plant parasites with which the plants and the farmer have to contend. To these there might be added also the plant itself. In certain cases a plant would be found with self-inflicted injuries. Pruning consists in removing a certain portion of the leaves or stems or branches of a plant. One effect of pruning on the pruned plant is the development of dormant buds. If the cuttings obtained in pruning are placed in a proper environment,—planted in the soil or placed in water—dormant buds also develop from the cuttings. I have observed a number of cases in which such buds have developed into what we ordinarily call bud sports. These are sudden vegetative changes which come true to type generally when propagated vegetatively and sometimes even sexually. In other words, such buds have shown new heritable variations. What, it may be asked, initiated these variations? I believe such variations appear as a response of the plant to the injury. This is just a hypothesis, proof might not be forthcoming. But, assuming for the present that injury does not initiate the variations or even that the genes for these variations appear without any stimulus, we can not deny that their manifestation was made possible by the development of dormant buds and this development in turn was due to the injury. In other words, even if injury might not be an initiating factor, it is surely a releasing factor.

Darwin in a discussion of variation under domestication in: *The Origin of Species by Means of Natural Selection*, states that not all variations arise sexually, that he had presented a list of sporting plants which had suddenly produced a single bud with a new and sometimes widely different character from that of the other buds on the same plant and that these bud variations can be propagated by grafts, offsets, etc, and sometimes by seed. He also pointed out that *these bud variations occur rarely under nature but frequently under culture*. To me this is a very significant statement of a condition which is to be expected, for under domestication, plants in successive vegetative generations have suffered more intentional mutilations than in nature.

I will now list and describe a number of the cases of bud variations which have been encountered in vegetatively propagated plants. Considering these cases in the light of cytological results of many workers to be reviewed later, it is highly probable that in these bud variations, injury was, if not the initiating, at least the releasing factor. Cases with which I am familiar are described briefly, together with supporting cases observed by other workers. Other cases with which I am not as familiar but which have been reported by others are given in table 1.

Sugar cane (*Saccharum officinarum* Linn.) is an important cultivated tropical plant. It is commercially propagated by cuttings, that is by a method which causes injury to the planting material right at the start. When new varieties are desired, true seeds are used in propagation, but once the new varieties are obtained, they are subsequently propagated exclusively by cuttings.

Numerous cases of bud mutations in sugar cane, arising from vegetatively propagated plants, have been reported by different authors from different regions, as Mauritius, Louisiana, Hawaii, West Indies, British India, Queensland, Porto Rico and the Philippines. Because I am familiar with the cases in the Philippines, as they were reported by my collaborators and myself, they will be described. Regarding cases reported in other countries, the following papers may be consulted: Stockdale (1906), Pomeroy (1919), Barker (1931), and Shamel (1922).

A description of the cases in the Philippines follows: A stalk with a row of double eyes at one side and a row of single eyes at the other formed throughout the entire stalk observed in a stool of P. B. 117 cane variety: a stalk of Mauritius Malagache bearing a node at the upper end of the stalk with more than five eyes; a stalk with eyeless nodes at the end of a flowering stalk; stalks without stripes produced by variety Gulisan, a white cane with green stripings; stalks with yellow stripes produced by Mauritius Malagache, which is a red unstriped cane; striped stalks produced by Luzon White, an unstriped variety; yellow stalks produced by a stool of Big Tanna which is a variety possessing stalks with purple and yellow stripes; a stalk bearing yellow stripes was found in M-1900, a variety with solid red stalks; a striped stalk was found in P.O.J. 213, an unstriped variety; a stalk half of which is striped and the other non-striped was found in Delagrabe variety, which is striped; a stalk with striped leaves was found in P.B. 363 cane variety; a branching stalk was occasionally observed on a number of seedling canes; a stalk of Linabnig showing mosaic infection on the leaves with side shoots not showing the leaf symptoms although carriers of the virus.

The different classes of bud variations found in sugar cane and reported in various countries may be grouped into the following classes: (*a*) side shoots differing from the parent stalk, (*b*) stalks in one stool differing in color from stalks in the same stools representing the parent variety, (*c*) a stalk with some joints striped and some unstriped, (*d*) a stalk showing variability in number of buds per node, (*e*) a stalk showing buds in unusual position,

(*f*) a stalk with striped leaves, (*g*) a stalk showing susceptibility to mosaic, bearing side shoots which were carriers of mosaic virus but not showing the disease.

Plant breeders have noted that the difference between the bud variations and mother plant in sugar cane is often as great as between recognized varieties, if not species. In fact there have been many clonal varieties of sugar cane in cultivation at one time or another which are of bud origin. For example the Louzier was the standard variety in Mauritius for many years. In that island alone, it is said, there were at one time eight or nine varieties which originated as sports and that some of them were fine canes and were extensively grown. Other examples are the Yellow Caledonia from Big Ribbon and the Rose Bamboo, or Cristalina, in Cuba from the parent variety Striped Mexican (Shamel, 1922). Actual experimental data are available to show the value of sports. D'Albuquerque and Bovell compared a sport (White) with the original stock (Ribbon) and found the sport to exceed the parent by nearly 910 kilograms of saccharose per acre.[2] Morris and Stockdale (1906) reported that in India one of the imported Mauritius canes was a ribbon cane called Striped Mauritius and that this gave red and white sports. The red proved better in richness of juice than any other cane grown at the station of Samalkota.

Hibiscus (*Hibiscus rosa-sinensis* Linn.) is an ornamental plant of which there are two common types. One type includes those varieties bearing a single corolla in each flower. The other type includes varieties bearing multiple corollas in each flower. For convenience, flowers of the first type have been described as single or simple, and flowers of the other, as double. These words have also been used to describe the corresponding types. I have worked with probably all varieties in the Philippines and have found that all double varieties and the old native single varieties are sterile and are, with few exceptions, incapable of sexual reproduction. They have to be propagated by cuttings. Bearing this fact in mind it is of interest to know if hibiscus plants which are propagated by cuttings have produced bud sports. Judging from the following list of cases observed in this College it appears that they have: A branch bearing double red flowers was produced by the Double Salmon variety; a Double Salmon plant produced a flower which was double red with some of the petals in the center of the flower remaining salmon; a branch of a Double Rose variety produced flowers which are double but carmine in color; Double Rose and Double Carmine varieties produced branches with single flowers; a branch of a red variety produced pink flowers; a branch of a pink variety produced white flowers; a branch of Pseudo Araña variety which bears red flowers, red filaments and anthers and red "eye", produced a flower with light salmon petals, filaments and anthers and red "eye".

The appearance of bud sports in ornamental hibiscus propagated by cuttings probably occurs wherever these plants are grown. Wilcox and Holt (1913), for example, reported some cases observed in Hawaii. They reported that on a Double Salmon there were occasionally dark red flowers and the

[2] Bud variation in the sugar cane. West Indian Bulletin 4: 73–74. 1904.

Double Yellow now and then bore a regular double flower half yellow and half salmon, or occasionally flowers that were salmon color throughout. Dr. Jean Schweizer, botanist of the Besoekishch Experiment Station in Java called my attention in 1927 to the occurrence in his garden of a bud variation con-

Fig. 1.—A plant, *Graptophyllum pictum* (Linn.) Griff., showing bud sports consisting of branches with solid green leaves shown at the right. These branches arose below a cut made in pruning the plant.

sisting of a branch bearing a simple red flower produced by a plant of the Double Salmon variety.

I have studied the sexual inheritance of some of these segregations reported above and found that one of them is sexually heritable. This is the case

Fig. 2.—A closer view of the two bud sports shown in figure 1. Note the wound near which the sports arose and which must have released them.

with the carmine somatic segregate. It is possible that others fall under this category.

Cassava (*Manihot utilissima* Pohl.) is an important tropical root crop. It is the source of cassava or tapioca starch and of the food known as tapioca seed, pearl, and flakes. Cassava roots are used also as live stock feed and as a source of alcohol. The plant is cultivated in several tropical countries. It is ordinarily propagated by stem cuttings. In Java and in the Philippines new varieties have been produced by seminal propagation. From plants propagated by cuttings, the following bud sports have been observed: In Java, a variety with solid green leaves have produced stalks bearing leaves with yellow to yellowish white areas. Seedlings of this sport produce only green leaves. In the Philippines however, this sport has been producing stalks with solid green leaves. Another case of bud sporting in cassava was found in variety Sinkong Manis. This variety has curly solid green leaves. The petiole is also greenish. A year ago over thirty cases of stalks producing non-curly leaves were observed from plants of this variety. From a stalk of the mutant, 19 plants were grown. A majority of the cuttings prepared from a supposedly mutant branch did not all come true to type. While different mutations found produced non-curly leaves, invariably there were leaves with trace of curly characteristics in some laminae of the leaves.

With banana (*Musa* spp.), many writers believe that bud mutation is one of the reasons for the existence of a great number of varieties of this plant, although others do not appear to subscribe fully to this belief. A number of cases, however, of supposed bud variations have been reported by different authors. Fawcett (1921) reported several. One of these cases is the Jamaican, or Gros Michel banana, the most important export variety of Jamaica, Fiji, and Costa Rica. Gros Michel is supposed to have sprung from the ordinary banana of Martinique, and was at first called Martinique banana, or Pouyat banana, having been introduced by one Jean F. Pouyat into Jamaica. A second case consisted of a tall form supposed to have come from the Chinese or Canary banana, which is dwarfish; this plant was sent to Fawcett by one Doctor Peres of Teneriffe. In Teneriffe this form is found scattered in plantations and is called male banana by the natives. A third case was also reported by Fawcett. In a bunch of "claret" bananas there were found "two" hands of green-colored fingers and one hand of both claret and green fingers. One finger "was half green and half claret." This would appear to be a case of "chimera". Kander (1923) reported two cases of abnormalities in plantains. One was of a sucker three months old, which bunched, the bunch having only one hand of five fingers. The second was of a plant producing two flower buds from the same stalk. A search was made for bud mutations in our College bananas. In 1915, among the many varieties introduced into the College, there were thirty-eight which were introduced each in the form of one sucker. After seven years, it was found that five of the thirty-eight, were still surviving and were represented by scores of plants. These plants were examined for possible bud mutations. None was observed in the first four. In the case of the fifth, which was represented in the plantation at the time of observation, by four hills, the plants of one hill had whitish trunks and in the other three, pinkish. Since all the plants in the four hills originally came from one single sucker, the one with the whitish trunk may be considered as a bud variation. In our banana

collection we have a strain of Buñgulan variety producing twin or triple bunches from each stalk. This characteristic is transmissible through asexual propagation.

In papaya (*Carica papaya* Linn.) the appearance of female flowers on male trees as a result of the removal of the terminal vegetative bud of the tree has been reported in many countries. Iorns (1908), conducted in Porto Rico experiments on the subject of sex change in the male papaya, and found that the removal of the growing tip caused sex change. An investigator in Ceylon (Anonymous, 1908), claimed that one cutting back is not always sufficient to produce an alteration and the tree has to be cut back more than once to make the treatment effective. His explanation for the phenomenon of sex reversal in papaya is that topping brings about a "concentrated or vigorous condition of the cell sap" which is necessary for the proper development of the ovary. According to Dr. D. A. Herbert, formerly professor and head of the Department of Plant Physiology in this College, decapitation of male trees for the purpose of transforming them into fruit-bearing forms was a wide-spread practice in Queensland, Australia. The effectiveness of the operation, he said, was then (1924) a recognized fact. Higgins and Holt (1914) gave a few positive cases of sex change in the male papaya as a result of decapitation and stated that no operation produces the change unfailingly as no alteration occurred in the great majority of the seedlings treated. The authors offered the bud variation concept as a possible explanation for this behavior. According to their hypothesis the potentialities to alter may have their inception in the different buds of the plant in the course of its development, and topping only forced the development of these buds and thus brought out whatever differences they might have. Hunn (1914) obtained four alterations out of 22 male plants cut back.

Because pineapple (*Ananas comosus* Merr.) is commercially propagated asexually, the varieties are in the nature of clons. Since it would be very difficult for pineapple seedling varieties to arise in the field, we may take it for granted that heritable variations found within a pineapple variety are due to unintentional propagation of bud sports. That pineapple bud sports do arise has been the experience in the Philippines as well as in Hawaii and Porto Rico. In our cultures we have found the Red Spanish variety, one with normal solid-green leaves, producing suckers bearing stripes of rose and white colors. The varieties we call Marikina, Baboy and Mindoro while differing in certain respects from Red Spanish bear many points of similarity and probably arose from Red Spanish originally as bud sports. The Smooth Cayenne variety which has supplanted the Red Spanish in popularity in the Philippines does not ordinarily produce slips. Although, we have observed plants of this variety producing slips. In 1925, Mr. Teodorico Reyes, one of our graduates, wrote to the author from Hawaii saying that he had seen in the plantations of the California Packing Corporation in Oahu green pineapple plants producing variegated or striped crowns on fruits which were similarly variegated or striped. Among smooth slips and suckers, spiny slips and suckers were found. Exceedingly large eyed fruits were produced from plants sister to those which produced small-eyed pines. In our local planting we have observed green plants producing dark purple crowns and slips.

An important characteristic of the Smooth Cayenne variety and certain hybrids with Smooth Cayenne as one of the parents is the appearance in the field of plants containing fasciated fruits or crowns or both. A fruit showing this abnormality is useless commercially and since it has been reported in Hawaii that as much as 50 per cent of the fruits in one field might be fasciated, one realizes the economic importance of this variation. This abnormality occurs probably in all countries growing Smooth Cayenne. I saw it in the pineapple cultures in Pasar Mingoe in Java. In the Philippines, we have collected samples from a number of private plantations. It is not known at present what causes the abnormality. In Hawaii, it is said that the use of mulch paper seemed to induce its production (Anonymous, 1927). Over-stimulation of the

Fig. 3.—A terminal bud sport in a *Codiaeum variegatum.* The sport arose on a branch produced below a wound.

plant is also one of the suspected causes. It might be that this abnormality is due to the injury caused by small organisms and is similar to the fasciation observed by Knox (1908) on *Oenotheras*, and might be caused by insects such as species of *Mompha.* Knox found these abnormalities non-heritable sexually. The pineapple fasciation is considered in Hawaii as non-hereditary. But, our local experiments have shown that such an abnormality persists in at least three vegetative generations.

Sarasa, or Morado (*Graptophyllum pictum* (Linn.) Griff.) is a common ornamental plant in the Philippines. It is propagated by cuttings. It is usually used as a hedge plant and occasionally for groupings. There are four varieties commonly grown, the Variegated Green, the Solid Green, Variegated Pur-

ple, and the Solid Purple. The first bears green leaves with white or yellowish white areas at the center. The second produces purple leaves with purplish-white areas at the center. Very often both varieties will be found throwing off bud sports with solid green leaves in the case of the Variegated Green and solid purple in the case of Variegated Purple, suggesting the origin of the

Fig. 4.—A branch of a variety of *Codiaeum variegatum* (Linn.) Blume. Note the bud sport consisting of a branch which had non- variegated leaves and which arose below a cut.

Solid Green and Solid Purple varieties. It is interesting to note that many of these bud sports have arisen very near the callus of wounds caused by pruning or by other agents (fig. 1 and 2). I have found one instance of a chimeral branch on the Solid Green. The chimera is sectorial, the sectors con-

sisting of purple and green, suggesting that the Variegated Purple arose as bud sport of green.

Croton, or San Francisco (*Codiaeum variegatum* (Linn.) Blume.), is a very popular ornamental plant in the Tropics. It is raised for its differently colored and highly variegated foliage. There are in the Philippines no less than eighteen varieties of this plant. It is propagated by cuttings. Judging from the evidence we have it is probable that many of these varieties originated as bud sports. I reported (Mendiola, 1926a) the following bud sports, the first four of which were observed in a variety which has entire, obovate leaves, with acute apex, green in color with various degrees of spottings of yellow. The first, and evidently the most common, consists of one branch with all leaves longer and linear. This branch is produced laterally from the main stem of the parent plant. A second sport is similar to the first except that only the terminal leaves of the branch have changed in shape and size. It also has arisen from two forms which differ only in color. A third sport is a branch on which the leaves are of the same shape and size as those of the parent variety, but all are green. The first and third variations appear like the two old forms and it is likely that such old forms originated as bud sports of the variety which produced these mutations. In my judgment the second bud sport produced an entirely new form.

The following bud variations are most probably mutations also, although experiments to test them have not been completed. One of these variations consists of a branch the terminal leaves of which are of different sizes and shapes (fig. 3). Some are linear and longer than the parent. Some are intermediate in shape and in size, compared with the leaves of the parent and those which are very narrow. Still others are linearly two or three lobed, the lobes being connected as in some old forms, with a naked midrib. Should this bud variation prove a mutation, it will represent an entirely new form. Another case consists of two varieties, the leaves of which are green with spottings of yellow, but which produced branches with practically all the leaves green. Another variety the leaves of which show irregular yellowish white patches on both sides of the midrib produced branches near wounds with solid green leaves (fig. 4). Still another variation was produced by a parent form which has linear lanceolate leaves, which are dark purple tinged with green and yellow. The variation consisted in a branch without the purple color. This variation has a counterpart in an old form which has been reported by Plant Breeding students from two different provinces. As this form is very rare and as the owner of the plant which produced the variation declared the new branch was not a case of budding or grafting, it appears very probable that the old form arose as a bud mutation as indicated by the case under report.

It is interesting to note that upon reviewing the photographs of a number of these *Codiaeum* sports taken several years ago I found that they show that the branches arise near cuts inflicted by pruning.

Buntot tigre (*Cordyline roxburghiana* (Schultes) Merr.) is commonly cultivated for its ornamental foliage. It is also grown as a fiber plant. The leaves are variegated with light green to very dark green irregular patches on both surfaces. This plant is propagated by suckers. A bud sport from this green-leafed plant was found. This mutant had also variegated leaves at the center but the margin had longitudinal yellow stripings originating from

the base and extending to its tip. This mutant reproduces true to type through propagation by suckers. Leaf cuttings of the bud sport, however, produced plants like the original parent. This is a case, typical of cases involving chimeras, in which the same plant produces different offspring through the use of different parts for vegetative propagation (fig. 5).

There are several species of papua (*Nothopanax* spp.) cultivated in the Philippines as foliage ornamentals. They are propagated by cuttings. Most of these *Nothopanax* plants bear solid green leaves. In several species, however, there are horticultural varieties bearing variegated leaves. The variegated forms evidently originated as bud sports for we find such sports arising at present or producing reversion to the parent type. An interesting case of a

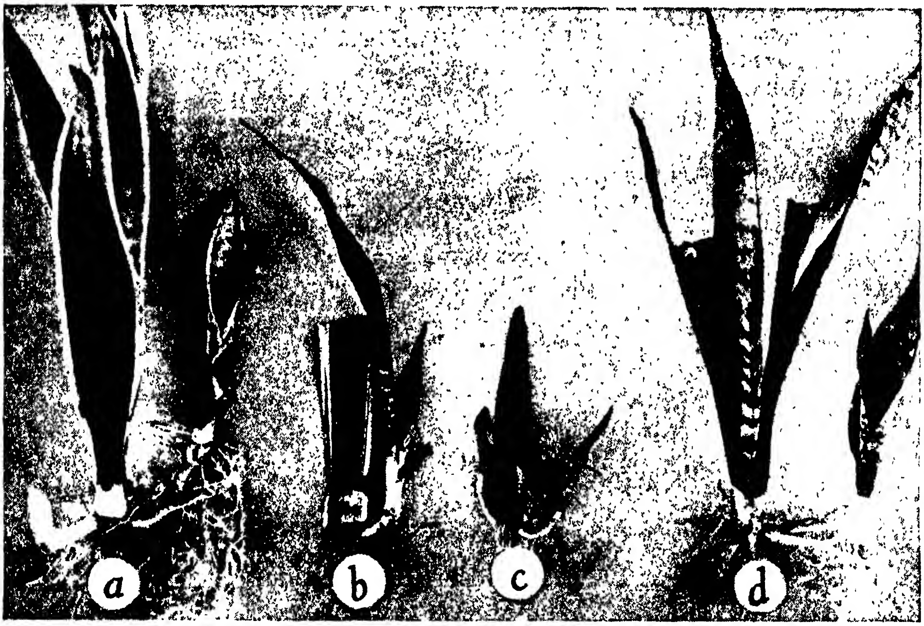

Fig. 5.—*Cordyline Roxburghiana* (Schultes) Merr.
(a) A bud sport, the asexual offspring of which coming from the rhizome is like itself.
(b) A leaf of the sport producing a plant which is a reversion to the parent.
(c) A leaf of the parent reproducing plants like the parent.
(d) A parent plant reproducing plants like itself.

bud sport or somatic reversion in *Nothopanax* was shown to me by Professor Harold Cuzner of the local School of Forestry. Near the back porch of his house on the Campus there is a papua plant of the species *N. guilfoylei* (Cogn. and March) Merr. belonging to the variety we call *platito* (small plate), so called because the leaves are round and curved along the edges forming a saucer like blade. This particular plant has leaves about 5 to 10 cm. in diameter with white borders and somewhat serrated margin. This plant produced a bud sport on a branch pruned three successive times. The sport is very different from the other branches of the plant. (fig. 6 and 7). The

leaves of this bud sport are solid green, possess entire margin and are 2 to 4 times larger in diameter than the parent leaves. As I have mentioned, the branch came out after three successive prunings. Professor Cuzner told me that a similar sport exists in his yard at San Juan Heights, Manila.

Arrowroot (*Maranta arundinnacea* Linn.) is an annual plant which is grown for its starch-storing roots. It is propagated by suckers. It is a plant which has solid green leaves ordinarily. Occasionally one finds plants with variegated leaves. Evidence at hand shows that these variegated plants must have originated as bud sports.

Ornamental pandan (*Pandanus Sanderi* Hort) is another ornamental plant. I have in my collection several plants of this species which I originally secured in Zamboanga, in southern Mindanao. This species is quite ornamental because its leaves bear green and white or yellowish white stripes. It is propagated by suckers. I have observed that these plants have produced suckers with solid green leaves.

On the College Campus we have a number of clumps of *Arundo donax* Llanos. We are growing them as ornamentals because the leaves are variegated. This plant is propagated either by suckers or by cuttings. It will be noticed on these clumps that within a single hill which originally came from a single cutting there are stalks with all leaves variegated and stalks with all leaves solid green. There are also stalks with variegated leaves at the base but on which the variegation gradually disappears towards the top where the last leaves are solid green. The same kind of bud sports have been reported by Shamel (1917) elsewhere.

Doctor Capinpin of this College has used the plant *Blechum Brownei* Juss. in experimental production of variations and has found it easily responding to various media and producing, through propagation by leaf or stem cuttings or by rhizomes, green and striped variants reversibly.

TABLE 1

A list of bud sports arising from vegetatively propagated plants

NAME OF PARENT PLANT	DESCRIPTION OF SPORT	AUTHOR REPORTING
Anacardiaceae Mango, *Mangifera indica*	Trailing, weak stemmed habit, from Alphonse graft	Patwardhan (1930)
Apocynaceae Oleander, *Nerium oleander*	Striping of leaves	Shamel (1921)
Berberadaceae *Berberis vulgaris*	Seedy suckers from seedless	Bateson (1916)
Cactaceae Cactus, *Euphorbia lactea*	Irregularity and asymmetry in growth	Moore (1932)
Celestiaceae *Eunymus japonicus*	Totally white shoots from variegated plant	Bateson (1916)

TABLE 1 (Continued)

NAME OF PARENT PLANT	DESCRIPTION OF SPORT	AUTHOR REPORTING
Compositae Artichoke	Several kinds of leaf variations	Shamel (1917)
Dahlias	Various kinds	Shamel (1919b)
Convolvulaceae Sweet potato, *Ipomoea batatas*	Red rooted parent gave yellow rooted vegetative progeny	Harter (1926)
Sweet potato	White-skinned roots from red variety White-skinned from yellow variety Striped yellow-white from yellow	Rosa (1926)
Elaeagnaceae *Eleagnus pungens*	Back sporting into solid green leaves	Pomeroy (1921)
Euphorbiaceae Poinsettia, *Euphorbia pulcherrima*	Pink from red Red from pink Red and pink from pink	Robinson and Darrow (1929) Robinson (1931)
Geraniaceae *Pelargoniums*	Green from variegated	Bateson (1916)
Grammineae Variegated *Arundo donax*	Absence, whole or partial, of variegation	Shamel (1917)
Labiatae *Coleus*	Many types	Stout (1915)
Moraceae Fig	Variegation of fruit	Condit (1928)
Musaceae Dwarf banana, *Musa cavendishii*	10 different types	Cheesman (1933)
Palmae Date palm, *Phoenix dactylifera*	Board flat pinnae from a plant with narrow folded pinnae	Shamel (1930)
Pandanaceae *Pandanus utilis*	Change from three to one leaf spiral	Schaffner (1919)
Pittosporaceae *Pittosporum tobira* var. *variegatum*	Variegation of leaves	Shamel (1917c)

TABLE 1 (Continued)

NAME OF PARENT PLANT	DESCRIPTION OF SPORT	AUTHOR REPORTING
Rosaceae Apple	Numerous kinds	Shamel and Pomeroy (1932)
Apricot	Crinkled, dark green leaves; variegated leaves	Weldon (1928)
Peach, Merrill sport	Marking of the suture region. Time of ripening 3 weeks later than its parent variety, the Ontario	Weldon (1924)
Peach, Poe sport	Extremely angular appearance of fruit, sharp keel present; entire surface of fruit convoluted	Weldon (1926)
Peach	Low, spreading habit	Anderson and Dorsey (1929)
Prune, *Prunus domestica*	Very large fruits. Sexual parent had small fruits	Shamel (1919a)
Roses	Various kinds	Tillotson (1932)
Rubiaceae *Bouvardia*	Carnation scarlet from pink	Bateson (1916)
Bouvardia	Singles from doubles. White flowers from red or red-pinkish parent	Bateson (1916)
Gardenia sp.	Squat-like growth, more leaves and no spines	Stewart (1924)
Rutaceae Eureka lemon, *Citrus limonia* Osbeck	Sports involving inferiority in quantity and quality of fruits, and habit of growth, foliage characteristics, color, shape, size, texture, juiciness; pink fruit	Shamel *et al.* (1920) Shamel (1932)
Lisbon lemon, *Citrus limonia* Osbeck	Sports involving inferiority in quantity and quality of fruits, bad maturing season, and other characters named for bud variations of Eureka lemon	Shamel *et al.* (1920)
Orange	Dry, straw colored flesh from juicy blood red parent	Shamel (1918a)
Valencia orange	Variegated leaves and fruits	Shamel (1917)
Valencia orange, *Citrus sinensis* Osbeck	Many strains of lower production and of lower quality	Shamel *et al.* (1927)

TABLE 1 (Continued)

NAME OF PARENT PLANT	DESCRIPTION OF SPORT	AUTHOR REPORTING
Washington Navel orange, *Citrus sinensis* Osbeck	At least 18 strains have been found, some involving brown spotting, early ripening: Thomson strain, Washington strain Corrugated, Golden Buck-eye, dryness of fruit, Australian strain, characterized by low production and poor quality, Ribbed strain, Sheepnose strain	Shamel, Scott and Pomeroy (1918) Shamel, Pomeroy and Caryl (1923, 1924, 1925, 1926, 1927, 1928, 1929) Chace and Church (1930)
Solanaceae Irish potato	More than 80 kinds have been reported. Variegation, loss of tuber skin color, change of sprout color, changes in leaf forms, other types	Folsom (1923) Dorst (1924)
Irish potato	Different kinds	Asseyeva (1927)

Injury caused by plant pests. The effects on chromosome structure and chromosome distribution exerted by injuries caused by plant pests are worthy of consideration in connection with the subject of initiation of heritable variations in plants. Plant pests attack all morphological parts of the plant, roots, stems, leaves, flowers and fruits. If injuries on these parts cause chromosomal changes then those changes which happen to be in the cells capable of regeneration might cause important bud mutations.

A study of literature shows that chromosomal aberrations in plant cells caused by pest injuries have actually been observed. According to Shull (1912), Strassburger reported that female specimens of *Melandrium,* a form of *Lychnis dioica* L., changed to apparent hermaphrodites as a result of infection with anther smut *Ustilago violacea* and he believed that all cases of hermaphroditism which had been reported in this species were probably due to infection by *Ustilago.* Professor Doncaster of the University of Cambridge tested the influence of *Ustilago* upon *Lychnis* by artificial infection and obtained results which were corroborative of Strassburger's.

Harrison (1924) reported that female structures arise on male plants of *Salix* as a result of infection by Eriophyid mites, particularly *Epitrimerus salicobius.* He also cites other cases reported by different workers consisting of the production of female flowers on the male spikes of *Carex praecox* due to infection by *Ustilago caricis;* of *Buchloe dactyloides* attacked by *Tilletia buchloeana;* also a smut causing fungus; female flowers in the male inflorescence of *Zea*

Fig. 6.—A plant of *Nothopanax guilfoylei* (Cogn. and March) Merr. showing a bud sport consisting of a branch, shown at the right, with much larger leaves, which have entire margin and solid green color. The parent plant has much smaller leaves which have serrated margin and variegated color.

Fig. 7.—A closer view of the bud sport shown in figure 6. Note that the sport arose from a branch which had sufferred three successive prunings, as shown by the wounds.

mays, var. *tunicata* due to infection by *Ustilago Maydis;* sterile flowers crowning the flower spike of the grape hyacinth *Muscari comosum* tending to become sexual under the influence of *Ustilago Vaillantii.* He claimed many other examples could be cited.

Kostoff and Kendall (1929) found irregular chromosome distribution in the cells of the flower buds of *Lycium halimifolium* Mill. parasitised by an Eriophyid mite. These workers declare that their observations indicate the possibility of plant parasites as factors in plant evolution.

Injury caused by different degrees of temperature and different light intensities. Since temperature and light are important factors affecting the growth of plant, we would expect that they would play also an important part in the initiation of variations in plants. Darwin in his discussion of bud variation (Shamel, 1918b) states that dahlias propagated by tubers under the hot climate of St. Domingo varied much. According to Malloch (1922), Schaffner (1921) observed teratological flowers and complete sexual reversal when hemp plants were grown on shallow benches in the greenhouse with low light intensity.

EXPERIMENTAL RESULTS OF INITIATION OF HERITABLE VARIATIONS BY INJURY

Artificial parthenogenesis as forerunner. The forerunners of the discoveries of heritable variations caused by injury were, it seems to me, the results of experiments on artificial parthenogenesis. It will be recalled that various cytologists have shown that the egg of certain animals, as of the frog, may be made to develop by pricking it with a needle. Sharp (1921) cites, for example, the work of such authorities as Guyer, Herlant, McClendon, Loeb, Bancroft, and Bataillon in this connection. Sharp also cites Heilbroun as showing that the egg of *Cumingia* can be induced to undergo maturation by agencies which release the fluid cytoplasm from the restraint of the tough vitelline membrance. Similar experiments have been made with plants. Davis and Kulkarni (1930) cite, for example, the work of Haberlandt. According to them, Haberlandt obtained early stages of parthenogenetic embryos in *Oenothera lamarckiana* and *Oe. muricata* by pinching the ovaries, by pricking them with a needle and by the castration of young flowers; and Haberlandt holds that the causes of the parthenogenetic development were hormones liberated as the result of the wounding of the tissue or the death of cells.

Artificial production of permanent variations through various external agencies most of which are injurious to the plant. These

experiments were performed especially to demonstrate the inheritance of acquired characters. That many of them failed to show inheritance of acquired characters does not mean that the injuries did not produce permanent variations. The investigators were looking for inheritance of the effects of injuries and naturally changes in the offspring which are not like the changes caused by injuries were bound to escape attention. It seems to me that some of the expectations in these experiments approach the ridiculous. For example, if the top of a plant is pruned off it is ridiculous to expect that a topless progeny will be produced. It will be recalled that Weismann in a similar way tried to find out if tailless mice could be produced by continuous cutting off of the tail of stock animals. He cut off the tail of mice for many generations and declared he did not obtain a tailless offspring. Many experiments on the inheritance of acquired characters have been performed with the same expectation. The real value of these experiments lies in the nature of the changes produced by the injuries, although these changes are not necessarily similar to those produced directly by such injuries.

One of the most commonly cited experiments on artificial production of heritable variations are those of Blaringhem (1908). Blaringhem performed different kinds of mutilations on the corn plant and found, according to his reports, cases of permanent variations. Lacking confirmation and considering the heterozygous condition of corn, Blaringhem's results are considered doubtful by many geneticists.

Gager (1908) treated the germ cells of *Oenothera* with radium rays and obtained variations, one of which bred true.

Macdougal (1911) by injecting various salts into ovaries of *Raimania*, a biennial species, obtained seedlings which behaved as annuals. With *Oenothera* he obtained one seedling which differed from the parent.

Goodspeed (1930) reported that three recessive monogenic mutations induced by treatment of *Nicotiana tabacum* var. *purpurea* with X-rays and radium were produced. The mutations involved pink flower color, pistillody of the androecium, and albino seedlings.

Lindstrom (1933) obtained four sexual mutations of tomato by radium treatment of young growing tips and two from radiated seeds. Three of these six heritable variants affected chlorophyll characters, two morphological characters, and one caused sterility and stunting of the entire plant.

In addition to plants, bacteria, infusorians, and higher forms of animals have been used in experiments on artificial production of

heritable variations. One of the classical experiments with higher animals is that of Brown Sequard. He mutilated guinea pigs in various parts of the body, thereby inducing epileptic tendencies which we now call the Brown-Sequard phenomena. The experiments are said to have extended through forty years. He claimed some of these tendencies were inherited, a claim which has been confirmed by other workers.

Following, in significance, the experiments on artificial parthenogenesis and production of artificial variations come the experiments on the alteration of chromosomes by injury. Pritchard (1916) by removing flowers, flower buds or leaves of *Cannabis sativus* plants was able to alter their sex expression. In addition to mutilation, he treated groups of plants in various ways, covered the top with Manila paper bag and injected into the stem a solution of dextrose, maltose, glucose, asparagin or pyriden. In all cases he obtained alteration of sex expression. While he did not ignore the possibility of these other treatments producing the effect on sex, he claimed that the chief cause was probably the removal of parts which caused "disturbances of the plants' physiological equilibrium."

Daniel (1914-1915), working on graft hybrids found that graft hybridization gave rise to characters not previously possessed by either the stock or the scion concerned in its formation. According to Stout (1920), Winkler was able to produce a true graft hybrid between the tomato and the nightshade by decapitation of the graft. The hybrid was a true graft hybrid because there was a fusion of vegetative cells of the stock and scion. The graft referred to was called by Winkler, *Solanum darwinianum*.[4] Now, it may be asked, if decapitation has caused a fusion of cells of stock and scion, why can not decapitation cause fusion of cells of an ungrafted plant? There is no reason to suppose that it can not, and if such fusion of cells can take place, then we may expect the production of polyploid cells in a plant as a result of decapitation or of injury.

Metaphany, which is defined as internal hybridization resulting in the formation of intermediate structures, has been observed according to Cook (1923), in several species of *Juglans* and *Hicoria* on trees growing under unfavorable conditions or *where the trees have been injured so that latent buds developed out of season.*

According to Gates (1924) Marchals reported in 1909 that he was able to establish tetraploid races of various species of mosses, such as *Barbula muralis, Funaria hygrometrica, Bryum capillare, B.*

[4] The Journal of Heredity 5: 520. 1914.

coespiticium, Amblytegium serpens, and *Mnium hornum,* by wounding the sporophyte. The sex organs of the new races were larger and had proportionally larger cells and nuclei. Gates also cites similar results by Schweizer with the moss *Splachum sphericum.* Recently, Kostoff (1930) reported chromosomal aberrants and gene mutations in *Nicotiana* obtained by grafting. According to Babcock and Clausen (1927) Nemec by narcotizing the root tips of vetch, pea, and onion, was able to produce polyploid cells. Lindstroom and Koos (1931) reported that by decapitating tomato plants they were able to obtain diploid as well as haploid shoots and that deploids were converted by the same method into tetraploids. Using *Lycopersicum pimpinellifolium,* Lindstrom (1932) by the same method as used with *L. esculentum* was able to obtain tetraploids from a homozygous plant. The tetraploids were highly fertile and had already remained constant for more than three generations. According to Karpetchenko (1932) tetraploid cabbage plants have been developed in the laboratory by Mrs. S. A. Schavinskaya by means of adventive shoots from callus produced by decapitation of young plants.

THEORETICAL CONSIDERATION OF POSSIBILITY OF INITIATION OF HERITABLE VARIATIONS BY INJURY

In addition to the observational and experimental evidence already presented, which tends to prove that injury causes heritable somatic variations, I would like to present evidence of a theoretical nature.

The fundamental properties of living matter are assimilation, growth, and reproduction. For the perpetuation of life, which is life's most important function, reproduction is the most essential, although it depends partly on and involves assimilation and growth. Any influence which tends to jeopardize life directly or indirectly should tend to draw from the individual a response in the form of variations, even though such influence may be favorable for assimilation or growth.

Many times these variations are large enough to be useful in plant improvement. And I believe there are cases where they are large enough to place the plants inheriting them in the category of new species.

There are biologists who can not see in the environment any primary factor in evolution. One of these, Dr. Richard Woltereck of Leipzig University, who recently delivered several lectures on the Campus, denied in his lectures that there is any primary external

factor of evolution and claimed that this factor lies in an "immanent force" obeying an "immanent law."

By denying the effect of environment on evolution and by failure to ascribe any purpose to evolution, Doctor Woltereck and the others of his school are placing this important biological question outside the realm of scientific inquiry. Their theory amounts to a dogma, incapable of scientific demonstration, for how could one isolate an organism or even a cell or even a gene if these were possible, from an environment?

By ascribing to organic evolution a purpose which can be expressed at least in terms of various biological facts we already know—chemical, physiological, and others,—we keep the theory of evolution as a scientific theory without denying that the organism itself, apart from its environment, has much to do with the fact that species produce other species.

Let us recall the simple commonly accepted fact that an individual is the product of genes and environment. Influences threatening life may act directly on the genes or may come from the genes themselves, or from the environment or from both. It should be recalled that the method of reproduction of the most primitive organism was by simple division which in a way may be considered as a form of self-originated injury. Sexual reproduction came about as a heritable variation in the same way that the details of reproduction characteristic of different species must have appeared as heritable variations. Any influence tending to interfere with any of the details of reproduction whether in the simple or in its more complex types should tend to produce variations. Some of these details are not visible either to the naked or the aided eye. Those which are visible and we understand more or less are production of flowers, fertility, compatibility, pollination, gamete formation, fertilization and fruit formation. It will be noted that all of these involve chemical and physiological functions of a plant. It seems an established fact that certain microscopically visible structures which are found in the cell and called chromosomes are the bearers of substances which govern the development of a living individual. Certain biologists imagine these substances existing as groups of separate bodies called genes. If these exist at all they must be very small for they are not visible even with the aid of a powerful microscope. It may be taken for granted that genes from one germ cell may combine with genes from another and that genes from one cell may be altered in such a way as to cause or show an alteration in the individuals arising from it subsequently. These suppositions are

based on results of experimental breeding. The behavior of chromosomes, manifested in different phenomena such as increase or decrease in chromosome number, change of chromosome structure, and the supposed alteration or rearrangement of position of genes may, however, not necessarily be the ultimate cause of the appearance of corresponding variations. The real cause may lie farther back, and it is, in my opinion, to be found in the chemico-physiological process taking place in the living cell.

The gene is undoubtedly a chemico-physiological substance capable of assimilation, growth and multiplication and capable of reacting with other chemical substances. As some authority has mentioned, the phenomenon of hybridity and of segregation suggest that probably the reaction taking place between genes is a reversible chemical reaction. This may be illustrated as follows:

$$A + B \rightleftarrows C + D$$

The reaction may be complete or incomplete in a given germ cell; yet, one reaction may be complete while another may not. If all reactions become completed then there will be no trace of reactants. If incomplete, there will be reactants and resultants. According to this chemical view the results of crossing suggest that variations occur as a result of complex reactions and that heritable variations are to be accounted for by the degree of completeness of reactions. If this be true then it should follow that factors affecting chemical reactions affect similarly the production of heritable variations. It is known in chemistry that chemical reaction is affected by temperature, pressure, radiant energy and the characters of the products formed. These factors may hasten or delay the reactions. It is significant to note that many experiments with both plants and animals have shown that increased temperature may accelerate the production of mutations. The same may be said of radiation, with X-rays, with length of day, etc. More important than these factors are those which cause the completeness of reaction. It is known that a chemical reaction may be completed, either whenever the nature of the reactants and resultants make the action irreversible or when the products of the reaction are separated from each other as fast as they are formed.

Essentially, then, we may suppose that new heritable variations arise as a result of the production of genic chemical substances, irreducible into the reactants for the time being and as a response of the plant to influences which tend to prevent the normal reproduction reactions. In other words we may say that

genic inequilibrium and injuries to plants which are bound to affect the chemical and therefore genic balance in the cells may initiate heritable variations, at least, permit the manifestations of these variations. De Vries (1909, 1910) once assumed that new heritable variations arise as a result of a combination of extremely favorable and extremely unfavorable influences, without giving a hint as to how favorable or how unfavorable the influences should be. I maintain, however, that injuries to plants constitute one of those causes, for injuries may be considered in one respect as favorable to the plant, and in another, as unfavorable. As an example of injury, I would cite pruning, a general practice in crop production and with which a number of bud sports reported in this paper were found connected. The following abstracts from Chandler's (1925) account of pruning gives the different effects of this injury.

Pruning, particularly cutting back a tree, causes an increased vigor of top growth, the leaves being larger and greener and length growth continuing later in the growing season. But, pruning, also, is a dwarfing process, the size of the tree generally being reduced by the amount of wood cut away and in addition by the reduction in growth caused by the reduced leaf surface. Generally, as trees grow older, pruning reduces root growth more than top growth. Under most conditions pruning seems to reduce total growth as much as it reduces the leaf surface; and under some conditions it reduces it more, a given leaf area leaving in the trees less dry matter than is left by the same leaf area in unpruned trees. Pruning generally reduces the amount of fruit borne by young trees more than it reduces the size of the tree; and under some conditions the dwarfing effect of the extra amount of fruit borne by the unpruned tree may be as great as the dwarfing effect of moderate pruning. *Pruning may be severe enough to cause the development of a vegetative condition unfavorable for fruit-bud formation.* Pruning may greatly reduce the crop of young trees simply by reducing the bearing surface, both the pruned and the unpruned tree being highly fruitful but the pruned tree being the smaller. The invigorating effect of pruning is much more striking with old trees and with trees growing where the supply of water or of nitrogen or both is low, than with young trees having an adequate supply of water and nitrogen. Pruning an old tree before blooming time may cause a larger percentage of the flowers to set fruit, and seems to reduce the tendency of the tree to bear in alternate years. All these effects of pruning can be traced to the physiological inequilibrium which it causes in the plant.

There might be another effect of pruning on the tissues immediately surrounding the wound or those exposed by the wounding. One who has followed the work of Dr. H. J. Muller of the University of Texas and of others on the modification of the gene by exposure to radio-active substances can not but be impressed by the probability that radio-active substances found in nature must be playing an important part in the production of somatic variations. It will be recalled that physicists have found that radio-activity is a property of many things, of water in rain, rivers, springs, wells, and the ocean; in sand of the seashore; in sedimentary rocks, in mud and the earth's atmosphere; and that all plants and animals are *radiotonus*, that is they are adjusted to a normal degree of radio-activity in their environment. When a plant is wounded the exposed tissues become more susceptible to the effect of radio-active substances than before, either because protecting cells have been removed or radio-active substances are brought closer to the exposed cells. The result in either case is possibly again a physio-chemical inequilibrium in the cell affecting at times the genes or the chromosomes.

The same may be said with regard to the greater susceptibility of the exposed cells to changes in temperature and light intensity.

With the evidence already presented it is hard to escape the conclusion that mechanical injury, whether caused by the propagation tools, by insect bites or other agents is a cause in the production of new heritable variations. Such variations may mean improvement of a crop, in which they occur, or degeneration. Such a conclusion will help clarify certain questions which have puzzled us heretofore. Such is the case, for example, with degeneration or running out of clonal varieties or the failure of vegetative offspring to come true to the types of the parents. Certain explanations have, of course, been offered to explain these important phenomena but while these explanations would appear satisfactory in certain cases or in certain respects, they do not give a complete answer. It would seem that degeneration is, in part at least, to be explained by the appearance of degenerate strains arising from bud sports caused by injuries.

THE NEW METHOD OF PLANT IMPROVEMENT EXPLAINED

To summarize the preceding discussions: I have pointed out that existing methods of improvement are based on *natural exposed variations* among plants. That is, variations that are already in existence and visible. They consist of natural systematic groups; seminal mutations; natural hybrids; bud mutations unintentionally prop-

agated or already severed from the mother plants; and variations produced by artificial crossing, by seed propagation without inbreeding and by inbreeding.

I am proposing a new method of improvement based on artificial and hidden variations. Variations already initiated in the plant but lying dormant, although capable of manifestation if encouraged vegetatively, and those to be initiated by certain agents, such as by injury. I have cited the results of observations proving the existence of latent variations in plants, and the initiation of new variations by injury, both in agricultural practice and in experimental work. I have also explained in a theoretical way how this initiation might be taking place.

I will now explain the new method of plant improvement which I am proposing and how it involves both the initiation and the release of variations in plants.

The essence of the new method is the propagation of plants vegetatively in such a way as to encourage maximum vegetative development and to cause as much injury to the parent plant and propagation units as successful propagation will allow. The injury is expected to initiate new variations whenever the plants are in condition to respond to this agent, and the propagation to release latent or newly initiated variations as well as to place them in condition for artificial selection.

The method of vegetative propagation proposed will consist of the following phases:

1. Vegetative propagation of plants not usually propagated in this way. Under this group fall such plants as rice, cotton, corn, different food legumes.
2. Vegetative propagation of plants usually propagated by seed but which may be propagated vegetatively. The methods used will involve parts not heretofore used for this purpose.
3. Vegetative propagation of plants, now ordinarily propagated asexually, by a method involving the following alterations of the old method:
   a. Use of smaller propagating pieces so there will be fewer buds to a cutting.
   b. Use of more buds or cuttings to a mother plant.
   c. Use of parts not now used, such as leaves in certain plants and roots or both leaves and roots in others.

d. Use of materials artificially injured which usually do not bear any injury at all.

e. Increase in injury in the propagation by splitting the cuttings and by other means.

f. Introduction of short intervals between vegetative generations to cause growth of sports from cells which otherwise would die or mature.

I suppose some of you are ready to remind me that the method can not be expected to produce new variations, inasmuch as we now propagate plants vegetatively precisely for the reason that the method is supposed to insure trueness of the progeny to type of the mother plant. This is, indeed, true in general but it is not always true that vegetative propagation insures perpetuation of parental type, for experience has shown that plants propagated vegetatively are known to vary a great deal. Please remember the contents of table 1. Just to re-cite one example. The millions of Washington Navel orange trees constituting the most important materials of the citrus growing industry in the United States came originally from a limb bud sport. A study of these has shown that no less than 18 distinct true breeding strains economically important have appeared, although, being seedless, these trees have been produced by successive vegetative propagations. And to mention a very curious fact. What we call bud sports, which in our elementary courses in genetics we define as consisting of sudden *heritable* changes are sometimes the very ones which are *unstable* and manifest tendencies to produce reversions. Note, for example, the numerous cases of what I would call somatic reversions exhibited by plants arising from recent bud sports. It would seem that a more serious consideration of vegetative segregations will lead us to the conclusion that, after all, vegetative propagation is not usually an insurance against important heritable variabilities. If we have heretofore considered that plants propagated vegetatively always come true to type, it is probably because we have only considered conspicuous characters and have not paid closer attention to inconspicuous differences. In our test with segregations which differ markedly from their parents, such as in the double-bunched or triple-bunched banana, the many-eyed stalks of sugar cane, the curliness of leaves in cassava, we have found that vegetative inheritance is far from so complete a result as to lead us to conclude that vegetatively propagated plants do not always come true to type, even bud mutations themselves. This is especially the case with what we call ever-sporting varieties.

Vegetative propagation of plants not usually propagated in this way. Among agricultural crops there are very many which are

usually propagated by seed, either because it is more convenient to do so or because we have been accustomed to suppose that they could not be propagated asexually. To cite local examples, we have among our crops, rice, corn, tobacco, coconut, cacao, cotton, mungo, soybean and other economic legumes, many orchard fruits, as caimito, atis, anonas and a goodly number of vegetable plants customarily propagated by seed. With the possible exception of coconut, we should be able to propagate all these asexually. Undoubtedly, much advantage would be gained by previously treating the plants intended for vegetative propagation in such a way as to stimulate vegetative growth as branching, tillering, suckering or other natural growths which increase the amount of propagating materials. In the case of rice for example, we have been accustomed to suppose that this plant could not be propagated vegetatively, yet it has been done without difficulty, by separation and use of young tillers. When tillers are to be used in this way it would be well to increase the rate of tiller production by favorably treating the plants, as we have done in this College, by planting single plants in hills and spacing them far apart. In this way the production of tillers is much encouraged; they have been increased from a maximum of 12 to as high as 53 in the Hambas variety. It is significant to note that in one rice plant which we have treated in this way we found a bud variation though it proved to be unstable.

In the propagation of coffee by graftage and Hevea rubber by buddage, plants which serve as sources of scion materials are pruned systematically to encourage the production of shoots which are used later as graft or bud wood.

That many species of plants which we are not accustomed to propagate asexually could be propagated by this method has been shown not only by local work but also by work done elsewhere. In this College we have propagated by cuttings, *Arachis hypogaea*, *Morus alba*, *Antidesma bunius*, *Passiflora quadrangularis*, *Eugenia jambos*, *Theobroma cacao*, *Derris philippinensis*, and *Eugenia jambolana*. These following species were also successfully propagated by marcottage, *Anona reticulata*, *Anona squamosa*, *Artocarpus integra*, *Averrhoa carambola* *Averrhoa bilimbi*, and *Cananga odorata*. Elsewhere, Rea (1928) has propagated cotton plants by cuttings.

Many failures in propagation by cuttings or marcottage could be avoided by using agents and bottom heat which stimulate rooting or root production. In the use of stimulants, the results of Curtis (1918) should prove helpful. Bearing in mind the attempts being made and the results which have been obtained in the artificial pro-

duction of heritable variations by injury through chemical and climatological treatments, it would appear that not only can we use such treatments to make vegetative propagation possible, but that we should use them for what they might actually accomplish in the initiation of heritable variations.

Vegetative propagation of plants usually propagated by seed, by application of methods involving the use of parts not used heretofore for propagation purposes. Among local crops, we have, falling under this category, coffee, Hevea rubber, kapok, mango, lansones, santol, chico, avocado and several more. What I am proposing in this case may be better understood by citing examples. With coffee, for instance, the usual method of asexual propagation is by cleft grafting. For scions we use top growth, leaving in this way no chance for latent buds and variation located in much older wood to develop. By propagation by cuttage these buds and variations will be given a chance, because older wood may be used. The feasibility of coffee propagation by cuttage has been demonstrated in our department by Doctor David; he has propagated the Robusta coffee successfully. Miraflores (1915) long ago proved that *Coffea arabica* may be propagated by cuttings.

Vegetative propagation of plants now ordinarily propagated asexually by methods involving certain alterations of the old practices. Many agricultural crops are propagated asexually. In the Philippines these include sugar cane, maguey and abaca; cassava and sweet potato in root crops; gabi in tuber crops and chico in fruit crops.

As a first modification of the vegetative methods now used in the propagation of these plants I am proposing (*a*) *the use of smaller propagating pieces.* In the cuttings, I would, if possible, reduce the size to the minimum so it would contain only one bud capable of development and enough internode part to support early growth. The aim is to obtain as many vegetative offspring as possible from a mother plant, and inflict a greater amount of injury to the offspring than is involved in the ordinary method of propagation. With sugar cane this has been done already. We have propagated these plants using one-bud cuttings with the cuttings either left whole or used split. By these cuttings an original plant has been multiplied very rapidly. With this method of propagation, more buds are allowed to produce plants than are ordinarily given a chance to grow and, in this way, coupled with the wounding made which is greater in intensity, we increase the chance of obtaining bud variations. Similarly, cuttings used in the propagation by cuttage of such plants

as cassava, sweet potato, and tuber or root pieces of plants propagated by the use of these parts will be decreased in size to the possible minimum. The same may be done with cuttings used in propagation by graftage. If, ordinarily, the scion consists of two or more nodes, then it will be cut so as to contain only one node.

In propagation by buddage, the unit used is ordinarily one bud so the number is already in the minimum. The modification being proposed is (*b*) *the use of more buds from each tree.* If it is possible to use all buds of a tree, then it should be done. (*c*) *The use of plant parts not now used* in vegetative propagation is the third modification in the list. To illustrate what is meant, I would cite the case of sweet potato. This plant is propagated by cuttings. From each vine usually two or three pieces are secured from the top end for planting. By using the leaves and roots, however, and by applying alterations (*a*) and (*b*) very many more plants can be raised from each mother plant. In reality, leaves have not been used in asexual propagation except in the case of a few species of plants. Roots have been used in a few cases. One possible reason for this practice is the fear or belief that leaves and roots can not be used for this purpose in the case of many plants. It is probable, however, that very many species of plants, in addition to the *Bryophilums* and *Begonias,* could be propagated by leaf or leaf and root cuttings. Here is a field open to botanists and plant propagators. These specialists could contribute greatly not only to our knowledge of regeneration, but also of the variability among plants so propagated from separate individual parent plants. It is gratifying to learn that Doctor Juliano of the College Plant Physiology Department has started work along this line and has already shown that leaves of certain varieties of *Codiaeum variegatum* will root (see fig. 8). Mr. Dawis of our Department has found the same thing not only with *Codiaeum* but also with *Fittonia verschaffelti* and *Nothopanax* plants. In my home I have propagated *Saintpaulia ionantha* by using leaves. Isbell (1931a and 1931b) has shown that sweet potato can be propagated by leaves and root cuttings and Irish potato and tomato by leaf and leaf cuttings. This worker found that small roots, leaf blades or parts of leaf blades of sweet potato with or without the petiole, especially of a heavily pigmented variety, regenerated roots and shoots. Other workers, Mullan (1931), Patwardhan (1931), Halma (1931) and Beilman (1932), have proved that adventitious roots and in many cases also a few plants develop from leaf cuttings of many species in families Acanthaceae, Commelinaceae, Convolvulaceae, Crassulaceae, Gesneriaceae, Labiatae, Lilia-

ceae, Piperaceae, Rosaceae, Urticaceae, and some gymnospermous species. (*d*) Another modification I would suggest would be to make *each propagating unit bear one wound or one other than the one it bears naturally.* For example, when a begonia leaf is severed from a stem, it is usually separated at the base of the petiole. This is the natural point of separation and the wound, if there be one, is a natural wound. Before planting such a leaf I would see that a part of the petiole is cut, thereby inflicting an artificial injury on the cutting.

Fig. 8.—Rooted leaves of *Codiaeum variegatum.* (Courtesy of Dr. J. B. Juliano).

(*e*) Then it is proposed that whenever possible and in addition to the above suggestions, vegetative propagation be done in such a way *as to increase the injury inflicted on the propagating parts.* The act of cutting, itself, constitutes an injury. Each cutting, however, may be given other injuries, such as by splitting them in part or throughout the whole, by inflicting other wounds especially on the bud itself if it can be done without killing it, by pinching them, and in other ways. (*f*) *Lastly, it is proposed that the interval of time be-*

tween vegetative generations be shortened as much as possible in order to give a chance for cells which ordinarily mature and die to develop into parts capable of being used for propagation. This shortening can be done by using a plant or its parts as early as possible in vegetative propagation in successive vegetative generations. Ordinarily, we use old plants and these plants naturally contain already a large amount of old or mature or dead cells. Among these cells there should be some in which latent heritable variations once existed but which had died with the death of the cells. By using very young plants continuously, it is quite likely that these latent variations could be given a chance to appear instead of their being lost.

You probably realize by now that the method being proposed involves many phases of agriculture and opens up new lines of research in various directions. We shall have to discover under what conditions the different alterations proposed in the method could be made; how we can propagate vegetatively plants which we have never propagated asexually, or only with difficulty; how we could grow cuttings of wood which we have found unresponsive so far to treatments we are accustomed to give; or how we could raise plants from roots or from leaves of such species or varieties of plants as have so far not been propagated or have not lent themselves to propagation by using these parts. Undoubtedly, in literature can be found experimental results which would be of direct or indirect aid in this line of work and these results will have to be gathered and arranged for convenient use.

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CHANGES IN CHEMICAL COMPOSITION OF CANTONESE EGGS IN HOLDING [1]

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INTRODUCTION

Eggs play an important rôle in the human diet. They are used in many ways as a constituent of many foods eaten daily.

As the eggs offered for sale are of varying ages, it is important to know the changes in the chemical composition that take place while they are held.

Many eggs remain unsold for different lengths of time, and when thus held they deteriorate, hence their eating quality naturally decreases. A keen buyer may recognize the market eggs that have undergone some degree of deterioration, and may buy only the fresher eggs, although at a higher price. In connection with such buying, these questions arise. Is there any difference in the nutritive value of a fresh egg and an egg which has been held for some time? Is it more economical to buy a fresh egg or an older egg? To be able to answer these questions, the experiments herein reported were conducted to determine the changes in the chemical composition that take place in market eggs when kept under ordinary room conditions.

Although eggs from various breeds of chicken are used in the Philippines as food and are almost equal in their nutritive value, it is the egg of the Los Baños Cantonese hen that was considered in this study.

Review of the important literature on the subject

Pennington, Jenkins, John, and Hicks (1914) stated that eggs are sensitive to the conditions under which they are kept, such as temperature and humidity, and that they undergo a variety of changes. They further stated that to judge the egg in the market, it is necessary to determine first the chemical composition of the absolutely fresh egg, so that a standard of comparison may be obtained. Then the chemical composition of the eggs on the market may be de-

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termined to see how much they differ from the fresh egg. These same investigators showed that when an egg is laid it is of a fairly constant chemical composition.

Leach (1920) quoted the proximate chemical composition of hen's eggs:

Chemical composition of hen's eggs

	REFUSE SHELLS	WATER	PROTEIN		FAT	ASH	FUEL VALUE PER POUND
			Nitrogen × 6.25	By difference			
White		86.2	12.3	13.0	0.2	0.6	250
Yolk		49.5	15.7	16.1	33.3	1.1	1705
Whole edible portion		73.7	13.4	14.8	10.5	1.0	720
As purchased	11.2	65.5	11.9	13.1	9.3	0.9	635

According to Santos and Adriano (1929), hen's egg has the following composition:

Eggs

FOOD MATERIALS	EDIBLE PORTION	MOISTURE	PROTEINS	FATS	ASH	CARBOHYDRATES	FUEL VALUE PER KGM.
	per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*calories*
Hen's egg .	88.60	73.67	12.57	12.02	1.07	0.67	1,660

According to Kojo (*cited by* Leach, 1920) there is .55 per cent dextrose in hen's eggs. Morner (*cited by* Leach, 1920) reported .3 to .5 per cent dextrose in such eggs.

Fronda and Dañgilan (unpublished study) found that during incubation there is an increase in the ash content of the whole edible portion of the duck's egg.

Santos and Pídlaoan (1931) found that as incubation proceeds, the calcium content of the shell, yolk and liquid, and albumen decreased, while that of the embryo duckling increased.

Greenlee (1911) using White Leghorn eggs in his studies found that fresh eggs weighed, on an average, 57.2237 grams and stale eggs, 51.3885 grams, giving a loss of weight of 11.9 per cent. He further found that the loss in water content increases in rate with the increase in room temperature.

Schroeder (1933) stated that an egg is never any better than at the time it is laid. He further stated that the characteristics of a fresh egg may be maintained longer if it is kept in a place which is cool and damp.

Clemente (1933) (unpublished study) states that under Los Baños conditions during the hotter months and under ordinary room

conditions, eggs kept up to 6 days are still good for frying, and up to 15 days for scrambling. During the cooler and rainy months eggs kept up to 10 days are still good for frying and up to 20 days for scrambling. The same investigator observed that even at the age of 6 days white rots were formed and mixed rots appeared on the eighteenth day and black rot on the twenty-seventh day. He further stated that as the eggs become older, the specific gravity becomes lower, decreasing from 1.066 for newly laid eggs to .861 for 90-day-old eggs.

The object of the present work was to determine the amount of changes in the water, protein, crude fats and ash content of Cantonese eggs at various ages.

The work was carried out in the Department of Chemistry, from October, 1931 to April, 1933.

MATERIALS AND METHODS

Materials

The Poultry Division, Department of Animal Husbandry, College of Agriculture, furnished the Cantonese eggs used in this study. So as not to affect the chemical composition of these eggs, the layers were fed throughout the period of the study with the same kind of feed. Two hundred Los Baños Cantonese eggs were used, one hundred fertile and one hundred infertile. These eggs were placed in the thesis room of the Chemistry Department. The initial weight (the weight at one day old) of each egg was recorded. Also, the weight of each egg at a definite date when analyzed was recorded.

Each egg at one day old weighed around 41 grams. All the eggs were kept under ordinary laboratory conditions. They were held under conditions that were as near as possible those under which market eggs are held. All the eggs were collected during the month of October, 1932.

In making analysis, eggs of 10 different ages were used. In each age there were 20 eggs, 10 fertile and 10 infertile. Only the edible portions were used. They were made homogeneous by thoroughly beating them in a 800 cc. beaker, care being taken to crush the embryo against the beaker. A representative sample was taken from the beaker for analysis.

One-day-old eggs. These eggs were fresh, hence they showed no sign of deterioration.

Seven-day-old eggs. All of these eggs were found unchanged. apparently.

Fourteen-day-old eggs. Eight eggs from each of the fertile and infertile lots showed no sign of rotting. Two from each lot were found to be white rots.

Twenty-one-day-old eggs. Seven fertile eggs remained apparently unchanged and eight infertile eggs showed no sign of deterioration. Three white rots were found in the fertile and two in the infertile.

Twenty-eight-day-old eggs. Three eggs appeared fresh among the fertile eggs and five among the infertile showed no sign of rotting, hence, there were seven white rots among the fertile and five among the infertile.

Thirty-five-day-old eggs. Among the fertile eggs there were eight white rots and two mixed rots, also among the infertile eggs there were eight white rots and two mixed rots.

Forty-two-day-old eggs. In the fertiles there were five white rots and five mixed rots. In the infertiles there were six white rots and four mixed rots.

Forty-nine-day-old eggs. There were four white rots and six mixed rots among the fertile eggs. In the infertile eggs there were five white rots and five mixed rots.

Fifty-six-day-old eggs. All of these eggs were mixed rots.

Methods and analysis

These analyses consisted of determining the actual amounts of water, protein, crude fats, and ash at various ages, ranging from one-day-old eggs up to sixty-three-day-old eggs. Analysis was performed at seven-day intervals with twenty samples for each age. Carbohydrates were determined by difference.

The directions for the determination of moisture, ash, crude protein and crude fats or ether extract were taken from the *Official and Tentative Methods of Analysis* compiled by the American Association of Official Agricultural Chemists (1930).

DISCUSSION OF RESULTS

The results of duplicate analysis are summarized in tables 1 to 5.

Moisture. Eggs contain a high percentage of moisture. Almost three-fourths of the entire edible portion of a fresh egg is water. As the egg grows older it loses a considerable amount of moisture,

decreasing from 74.04 per cent in one-day-old fertile eggs to 66.62 per cent (table 1) in sixty-three-day-old eggs. The total decrease of 7.42 per cent is equivalent to 6.4098 grams of moisture. This loss is very significant (table 3).

In case of the infertile eggs (table 2) the change is from 74.31 per cent in the one-day-old eggs to 67.13 per cent in the sixty-three-day-old eggs. The loss in sixty-three-days is 7.18 per cent.

The change of moisture content in infertile eggs is from 27.0674 grams in one-day-old eggs to 21.0753 grams (table 4) in sixty-three-day-old eggs or a total change of 5.9921 grams of water. The loss of 7.18 per cent is then equivalent to 5.9921 grams of moisture. This loss is very significant (table 4).

Table 5 shows that both fertile and infertile eggs have the same amount of moisture at all the ages, except at the age of thirty-five days where the amount of moisture in the infertile egg is greater than the amount of moisture in the fertile egg.

Ash. Tables 1 and 2 show an increase in the percentage of ash in both fertile and infertile eggs as they become older.

However, as shown in tables 3 and 4, at the ages of one day up to forty-nine days there is no significant difference in the total amounts of ash. At the ages, fifty-six days and sixty-three days, in both fertile eggs and infertile eggs, the total amount of ash in each case was greater than the total amount in one-day-old eggs. The differences are significant in favor of the older eggs (tables 3 and 4).

Table 5 shows that both fertile and infertile eggs have the same amount of ash in all the ages.

Protein. Tables 1 and 2 show that as the eggs become older there is an increase in the percentage of protein in both the fertile and the infertile eggs.

Tables 3 and 4 show the total amounts in grams of protein in both the fertile and infertile eggs at various ages.

However, when the total amounts of protein are considered, table 3 shows that from one-day old up to forty-two days old the total amounts of protein are the same. But when forty-nine days and fifty-six days old the total amounts of protein are each greater than the total amount of protein in one-day old eggs. The differences in amount are significant. Then, again, the total amount of protein in the eggs sixty-three days old is equal to the total amount in eggs of the first eight ages, that is from one-day old up to forty-two days old. From these results no definite conclusion can be drawn.

Table 4 shows in grams the total amounts of protein in infertile eggs. The total amount of protein in eggs of each of the ten ages was found to be equal. The results indicate, then, that there is no change in the amount of protein in the edible portion of infertile eggs.

Table 5 shows that both fertile and infertile eggs have the same amount of protein in all the ages.

Fat. The percentages of fat in both fertile and infertile eggs increase with age (tables 1 and 2).

However, when the total amounts in grams of fat in both fertile and infertile eggs (tables 3 and 4, respectively) are considered, it is found that the total amounts of fat in fertile eggs (table 3) at one day old up to thirty-five days old are the same in value. But the total amounts of fat in the four ages, that is in fertile eggs, from forty-two days old up to sixty-three days old were in each age greater than the total amount of fat in one day old fertile eggs (table 3). The differences are significant.

Table 4 shows that in infertile eggs from one day old and seven days old, the total amounts of fat are equal in value. But the amount in infertile eggs fourteen days old, twenty-one days old and twenty-eight days old is in each case greater than the total amount in one-day old eggs. The differences are significant (table 4).

Table 5 shows that both fertile and infertile eggs have the same amount of fat in all the ages, except at the age of forty-two days when the amount in the fertile egg is greater than that in the infertile egg.

Carbohydrates. Since carbohydrates were obtained by difference, any error in the analyses will naturally affect the results. Direct determination for carbohydrates was not carried out, so that any statement to the effect that carbohydrates increase or decrease with age can not be given in this paper.

According to Kojo (*cited by* Leach, 1920) there is .55 per cent dextrose in hen's eggs. Morner (*cited by* Leach, 1920) reported .3 to .5 per cent dextrose in such eggs. With this small amount of carbohydrates in eggs it seems unimportant to determine whether the amount changes or not.

SUMMARY

1. The percentages of composition and total amounts of moisture, ash, protein and fats in fertile and infertile Cantonese eggs at various ages were determined.

2. The moisture content of fertile and infertile eggs decreased with age.

3. In both fertile and infertile eggs there was no change in the total amounts of ash except in the eggs fifty-six days old and sixty-three days old where the total amount of ash was greater in each case than that in one-day old eggs.

4. In fertile eggs there was no change in the total amount of protein except in eggs forty-nine days old and fifty-six days old when the amount was in each case greater than that in one-day old eggs.

5. In infertile eggs there was no change in the amount of protein as the egg grew old.

6. In fertile eggs there was no change in the total amount of fats except in eggs forty-two days old, forty-nine days old, fifty-six days old and sixty-three days old when the amount was greater in each case than that in one-day old eggs.

7. In infertile eggs there was no change in the total amount of fat except in eggs fourteen days old, twenty-one days old, twenty-eight days old, forty-nine days old, fifty-six days old and sixty-three days old when the amount was in each case greater than that in one-day old eggs.

8. According to Clemente (1933) the longest time that an egg can be kept sufficiently good for scrambling is twenty days. Up to this time there was no change in the total amounts of ash, protein and fats, except in infertile eggs where at the age of fourteen days, twenty-one days and twenty-eight days the amount of fat was in each case greater than that in one-day old eggs.

9. Both fertile and infertile eggs had practically the same amount of moisture, ash, proteins and fats at all ages.

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TABLE 1

Percentage composition of fertile eggs at various ages

AGE	MOISTURE	ASH	PROTEIN	FATS	CARBOHYDRATES BY DIFFERENCE
days	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
1	74.04	.96	12.75	11.03	1.23
7	73.37	.97	12.84	11.38	1.34
14	72.87	.97	12.94	11.92	1.31
21	72.11	.99	13.39	12.01	1.50
28	70.72	1.06	13.75	12.55	1.92
35	70.28	1.08	13.87	12.82	1.95
42	69.89	1.13	14.37	13.14	1.48
49	68.73	1.18	14.84	13.53	1.73
56	67.67	1.24	15.05	13.83	2.21
63	66.62	1.31	15.65	14.75	1.67

TABLE 2

Percentage composition of infertile eggs at various ages

AGE	MOISTURE	ASH	PROTEIN	FATS	CARBOHYDRATES BY DIFFERENCE
days	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
1	74.31	1.02	13.05	10.55	1.07
7	73.15	.96	12.97	11.16	1.76
14	72.56	1.06	13.01	11.89	1.48
21	71.93	1.12	13.21	12.25	1.38
28	71.56	1.13	13.78	12.23	1.30
35	71.43	1.14	14.36	12.11	.95
42	71.19	1.06	14.61	12.03	1.10
49	69.53	1.15	14.88	13.39	1.05
56	69.53	1.25	15.04	13.21	.98
63	67.13	1.31	15.52	14.78	1.26

TABLE 3

Amounts of constituents of fertile eggs at various ages [a]

AGE	EDIBLE PORTION	MOISTURE	DIFFERENCE	ASH	DIFFERENCE	PROTEIN	DIFFERENCE	FATS	DIFFERENCE	CARBOHYDRATES BY DIFFERENCE	DIFFERENCE
days	*grams*	*grams*		*grams*		*grams*		*grams*		*grams*	
1	36.7859	27.2336		.3528		4.6907		4.0569		.4519	
		±.0798		±.0067		±.0426		±.0677		±.0486	
7	36.2745	26.8127	.6209	.3532	.0004	4.6578	.0329	4.1279	.0710	.5229	.0710
		±.0625	±.1015	±.0067	±.0141	±.0592	±.0728	±.0505	±.0848	±.0463	±.0671
14	35.8519	26.1236	1.1100	.3494	.0034	4.6382	.0625	4.2726	.2157	.4680	.0161
		±.0772	±.1113	±.0095	±.0141	±.0399	±.0583	±.0527	±.0860	±.0437	±.0656
21	35.0210	25.2522	1.9814	.3468	.0060	4.6909	.0002	4.2758	.2189	.4553	.0034
		±.0929	±.1225	±.0023	±.0100	±.0531	±.0678	±.0302	±.0742	±.0596	±.0775
28	33.9540	24.0138	3.2198	.3595	.0067	4.6690	.0217	4.2599	.2030	.6518	.1999
		±.0977	±.1261	±.1261	±.0141	±.0278	±.0436	±.0580	±.0894	±.0472	±.0678
35	33.3350	23.4228	3.8108	.3606	.0078	4.6266	.0641	4.2768	.2199	.6482	.1963
		±.1208	±.1449	±.0067	±.0141	±.0556	±.0700	±.0492	±.0837	±.0477	±.0686
42	32.8528	22.9642	4.2694	.3694	.0166	4.7192	.0285	4.3151	.2582	.4849	.0330
		±.1440	±.1646	±.0067	±.0141	±.0387	±.0574	±.0270	±.0728	±.0202	±.0529
49	32.9042	22.6130	4.6206	.2862	.0334	4.8815	.1908	4.4512	.3943	.5724	.1204
		±.1961	±.2116	±.0067	±.0141	±.0457	±.0624	±.0736	±.1000	±.0399	±.0633
56	32.7532	22.1670	5.0666	.4075	.0547	4.9278	.2371	4.5275	.4706	.7234	.2715
		±.1462	±.1667	±.0067	±.0141	±.0344	±.0548	±.0243	±.0721	±.0278	±.0566
63	31.2501	20.8238	6.4098	.4088	.0560	4.8839	.1932	4.6075	.5506	.5260	.0741
		±.1963	±.2119	±.0067	±.0141	±.0505	±.0663	±.0382	±.0781	±.0614	±.0787

[a] Value of difference is calculated by taking the amounts in one-day-old egg as the basis, that is, bv subtracting from or adding to the amounts in one-day-old egg each of the amounts in eggs seven days old up to sixty-three days old.

TABLE 4

Amounts of constituents of infertile eggs at various ages [a]

AGE	EDIBLE PORTION	MOISTURE	DIFFERENCE	ASH	DIFFERENCE	PROTEIN	DIFFERENCE	FATS	DIFFERENCE	CARBOHYDRATES BY DIFFERENCE	DIFFERENCE
days	*grams*	*grams*		*grams*		*grams*		*grams*		*grams*	
1	36.4281	27.0674		.3726		4.7514		3.8446		.3921	
		±.1104		±.0067		±.0535		±.0643		±.0350	
7	36.2059	26.4808	.5866	.3480	.0246	4.6976	.0538	4.0424	.1978	.6372	.2451
		±.0958	±.1460	±.0067	±.0141	±.0394	±.0663	±.0939	±.1136	±.0874	±.0938
14	35.9405	26.0812	.9862	.3806	.0180	4.6744	.0770	4.2708	.4262	.5334	.1413
		±.1209	±.1630	±.0095	±.0141	±.0323	±.0624	±.0491	±.0806	±.0301	±.0458
21	34.7010	24.9592	2.1082	.3902	.0176	4.6206	.1308	4.2515	.4069	.4794	.0873
		±.0650	±.1280	±.0067	±.0141	±.0323	±.0524	±.0370	±.0742	±.0530	±.0632
28	34.1607	24.4438	3.6236	.2865	.0139	4.7088	.0426	4.1762	.3316	.4453	.0532
		±.0643	±.1270	±.0028	±.0100	±.0316	±.0624	±.0491	±.0806	±.0691	±.0775
35	34.2067	24.4337	2.6347	.3905	.0179	4.9119	.1605	4.1439	.2993	.3276	.0645
		±.1056	±.1530	±.0017	±.0100	±.0393	±.0663	±.0786	±.1015	±.0496	±.0608
42	33.2494	23.6778	3.3896	.3534	.0192	4.8548	.1034	3.9970	.1524	.3665	.0256
		±.2189	±.2450	±.0032	±.0100	±.0410	±.0678	±.0442	±.0775	±.0269	±.0436
49	32.7531	22.7726	4.2948	.3767	.0041	4.87[illegible]6	.1232	4.3843	.5397	.3449	.0472
		±.1590	±.1930	±.0060	±.0141	±.0622	±.0748	±.0442	±.0775	±.0233	±.0412
56	32.5809	22.6518	4.4156	.4077	.0351	4.8976	.1462	4.3052	.4606	.3187	.0734
		±.1362	±.1750	±.0049	±.0100	±.0387	±.0663	±.0640	±.0905	±.0442	±.0557
63	31.3639	21.0753	5.9921	.4094	.0368	4.8378	.0864	4.6254	.7808	.4159	.0238
		±.3121	±.3300	±.0079	±.0100	±.0411	±.0678	±.0766	±.1000	±.0350	±.0489

[a] Value of difference is calculated by taking the amounts in one-day-old egg as the basis, that is, by subtracting from or adding to the amounts in one-day-old egg each of the amounts in eggs seven days old up to sixty-three days old.

TABLE 5

Showing a comparison between fertile and infertile eggs at various ages

AGE	MOISTURE			ASH			PROTEIN			FATS		
	Fertile egg	Infertile egg	DIFFERENCE	Fertile egg	Infertile egg	DIFFERENCE	Fertile egg	Infertile egg	DIFFERENCE	Fertile egg	Infertile egg	DIFFERENCE
days	*grams*	*grams*		*grams*	*grams*		*grams*	*grams*		*grams*	*grams*	
1	27.2336	27.0674	.1662	.3528	.3726	.0198	4.6907	4.7514	.0607	4.0569	3.8446	.2123
	±.0798	±.1104	±.1364	±.0067	±.0067	±.0141	±.0426	±.0535	±.0686	±.0677	±.0643	±.0933
7	26.6127	26.4808	.1319	.3532	.3480	.0052	4.6578	4.6976	.0398	4.1279	4.0424	.0855
	±.0625	±.0958	±.1144	±.0067	±.0067	±.0141	±.0592	±.0394	±.0714	±.0505	±.0939	±.1068
14	26.1236	26.0812	.0424	.3494	.3806	.0312	4.6382	4.6744	.0362	4.2726	4.2708	.0703
	±.0772	±.1209	±.1430	±.0095	±.0095	±.0390	±.0399	±.0323	±.0510	±.0527	±.0491	±.0616
21	25.2522	24.9592	.2930	.3468	.3902	.0434	4.6909	4.6206	.0703	4.2758	4.2515	.0243
	±.0929	±.0650	±.1131	±.0023	±.0067	±.0387	±.0531	±.0323	±.0620	±.0302	±.0370	±.0479
28	24.0938	24.4438	.3500	.3595	.3865	.0270	4.6690	4.7088	.0398	4.2599	4.1760	.0837
	±.0977	±.0643	±.1170	±.0067	±.0028	±.0102	±.0278	±.0316	±.0424	±.0580	±.0491	±.0762
35	23.4228	24.4327	1.0099	.3606	.3905	.0299	4.8266	4.9119	.0852	4.2768	4.1439	.1329
	±.1208	±.1056	±.1606	±.0067	±.0017	±.0101	±.0556	±.0393	±.0686	±.0492	±.0786	±.0927
42	22.9642	23.6778	.7136	.3694	.3534	.0160	4.7192	4.8548	.1356	4.3151	3.9970	.3181
	±.1440	±.2189	±.2610	±.0067	±.0032	±.0105	±.0387	±.0410	±.0566	±.0270	±.0442	±.0518
49	22.6130	22.7726	.1596	.3862	.3767	.0095	4.8815	4.8746	.0069	4.4512	4.3843	.0669
	±.1961	±.1590	±.2528	±.0067	±.0060	±.0118	±.0457	±.0522	±.0693	±.0736	±.0442	±.0860
56	22.1670	22.6518	.4848	.4075	.4077	.0002	4.9278	4.8976	.0302	4.5275	4.5275	.2223
	±.4462	±.1362	±.1975	±.0067	±.0049	±.0111	±.0344	±.0387	±.0520	±.0243	±.0640	±.0866
63	20.8238	21.0753	.2515	.4088	.4094	.0006	4.8839	4.8378	.0461	4.6075	4.6254	.0179
	±.1963	±.3121	±.3673	±.0067	±.0079	±.0141	±.0505	±.0411	±.0656	±.0382	±.0766	±.0860

ABSTRACT[1]

Preliminary studies on the influence of the presence of males upon the growth and maturity of pullets. ELEUTERIO P. ENRIQUEZ. (*Thesis presented for graduation, 1933, with the degree of Bachelor of Agriculture from the College of Agriculture No. 370; Experiment Station contribution No. 919*)—The object of this work was to determine the influence of the presence of males upon the growth and maturity of pullets.

There were 280 weanling Los Baños Cantonese chicks, approximately uniform in weight and size, used in this experiment. When the chicks were two months old, they were separated into lots based on sex. Lot I consisted of 50 females and no male; lot II consisted of 50 females and 10 males; lot III consisted of 50 females and 25 males; and lot IV was composed of 50 females and 50 males.

All the lots were given the same care and management.

The outstanding results obtained were: As to influence of males on growth, the average weight at the age of 32 weeks was 1,267.1 grams for lot I (no-male lot); 1,206.6 grams for lot II, (50 pullets to 10 cockerels); 1,189.1 grams for lot III (50 pullets to 25 cockerels); and 1,098.6 grams for lot IV (50 pullets to 50 cockerels). These results showed that the pullets gained more weight in the lot where there was no cockerel. As the number of cockerels were increased the pullets gained less in weight. Thus, the presence of males in the flock had a tendency to affect the size of the pullets adversely, although when the weights were treated statistically the differences between the different lots were insignificant.

As to maturity, the pullets in lot I (no-male lot) matured in 177.36 days; lot II (50 pullets to 10 cockerels) in 185.50 days; lot III (50 pullets to 25 cockerels) in 193.50 days; and lot IV (50 pullets to 50 cockerels) in 200.24 days. These results indicated that the presence of cockerels retarded the maturing of the pullets—the more cockerels there were in the lot the later the pullets matured.

The cockerels gained more weight in the lots where they were fewer, although the gain was not significant statistically. The

[1] Abstract prepared as part of the required theme work in English 3a, College of Agriculture.

average weight of the males at the age of 32 weeks was found to be 1,504.1 grams in lot II; 1,352.5 grams in lot III; and 1,308.6 grams in lot IV.

Most of the cockerels matured at 6 months of age.

—*Abstract by Alfonso S. Marcelo*

COLLEGE AND ALUMNI NOTES

The Board of Regents of the University of the Philippines in meeting on July 14, made Dr. G. O. Ocfemia permanent head of the Department of Plant Pathology and Dr. A. L. Teodoro the permanent head of the Department of Agricultural Engineering.

Three of our faculty members, Dr. Jose B. Juliano, Dr. Miguel Manresa and Dr. Valente Villegas were recently honored by being elected Fellows of the American Association for the Advancement of Science.

The College of Agriculture was awarded a cash premium amounting to ₱50 by the World's Grain Exhibition and Conference held at Regina, Canada, early in 1933. The College exhibit consisted of different kinds of grains and legumes.

The Dean of the College recently received from the Minister of Colonies of the French Republic a commemorative diploma awarded for the exhibit of several volumes of THE PHILIPPINE AGRICULTURIST at the Colonial and International Exposition held in Paris in 1931.

Lt. G. Peralta, Assistant Superintendent, and Dr. Jorge Simon, veterinarian, of the Iwahig Penal Colony, visited the College of Agriculture on September 21, 1933. They were mainly interested in animal husbandry work and were shown the different activities of the Department of Animal Husbandry.

An order was recently received by Dr. F. M. Fronda, from Ministry of Economic Affairs, Department of Agriculture, Bangkok, Siam for:

3 Cantonese cockerels at ₱6.00 each
8 Cantonese pullets at ₱6.00 each
3 Nagoya cockerels at ₱12.00 each
6 Nagoya pullet hens at ₱12.00 each

The order came through recommendation of Mr. Thongdee Resananda '24 now Head of Experiment Station at Kuan-Nieng, Siam. Mr. Resananda majored in poultry raising when he studied in this College.

Accompanied by Dr. Robert L. Pendleton of the Soils Department of this College, Dr. E. B. Copeland, Technical Adviser to the Secretary of Agriculture and Commerce and Director of the Economic Garden of the Bureau of Plant Industry at Camp Eldridge, Los Baños, and Founder and First Dean of the College of Agriculture, returned on September 20 from a month's trip to Mindanao and way ports. The trip was for the purpose of making agricultural, soils, and botanical studies. Particular attention was devoted to the location and extent of cogonals in Cotabato Province and their probable relation to locust infestation and damage. Studies were also made of the soil and agricultural conditions on new and old style rubber plantations, as exemplified by the Pathfinder Estate of the Goodyear Rubber Company at Kabasalan, Zamboanga Province, and the Rio Grande Estate at Kabakan, Cotabato Province. Limited time was also available for observations in Basilan, Jolo, Oriental Negros, and Cebu. As Doctor Copeland's scientific studies in the island of Mindanao commenced almost 30 years ago, and as he has retained his interest in the island, the trip proved to be exceedingly interesting as well as scientifically profitable. In addition to a large quantity of field notes, material brought back and available for research on our Campus consists of over 60 soil samples and over 600 photographic negatives of soil, agricultural, and forestry conditions.

The College lost in October by resignation three valuable men from the teaching force. Mr. Ramon A. Cruz, '23, instructor in the Department of Agricultural Chemistry, has accepted a more remunerative position as assistant chemist in the Philippine Refining Co. at Malabon, Rizal. Mr. Manuel R. Monsalud, B.S.S.T. '31, and Mr. Rafael B. Rotor, B.S.S.T. '33, graduate assistants in the Departments of Agronomy and Rural Economics, have accepted positions as chemists in the Paniqui Sugar Mills, Inc. at Paniqui, Tarlac. Mr. Rotor holds the degrees of B.Agr. '28, B.S.A. '30, and B.S.S.T. '33. Mr. Monsalud was one of the first two holders of the Bailon de la Rama Scholarships in sugar technology in the University of the Philippines. Mr. Monsalud in his senior year passed the Junior Chemist examination given by the Bureau of Civil Service in Manila on October 3, 1930.

The eighty-sixth regular scientific meeting of the Los Baños Biological Club was held in the Lecture Hall of the Poultry Building, College of Agriculture, on Thursday, September 21, 1933, at 7:30 p. m. The following papers were read and discussed.

"The reproductive activity of the Berkjala sows as affected by seasons."
By Dr. M. Mondoñedo

"The food of the inmates of the Correctional Institution for Women."
By Dr. F. O. Santos and Mr. N. A. Pidlaoan
(Paper read by Doctor Santos)

A concert of Chamber Music was given at Center on the evening of September 16 by students from the U. P. Conservatory of Music with two numbers by faculty members, a piano solo, by Prof. Jeno von Takacs and a violin solo by Prof. Ramon Topales.

The program was well balanced and admirably presented. The including of selections by Filipino composers is to be warmly commended.

The concert was under the auspices of the Rizal Fraternity Center, Los Baños Chapter in coöperation with the Manila Chapter.

Doctor Uichanco recently received a letter from Swasdi Viradeja '32. He is teaching in the Agricultural School at Korat. He writes of the growing interest in modern agriculture in Siam but bewails the shortage of men trained in such work. Mr. Viradeja is interested in pests of rice, tobacco, and vegetables and asks for information on literature bearing on these. He also writes that he plans to translate into Siamese a biology suitable for agricultural high schools and asks for counsel on this type of text.

A letter to Professor Yule from Basunie Saropie '33 tells briefly of his work on the committee in Palembeng, Sumatra to raise funds for relief of victims of the recent earthquake in that region. "I cannot tell you fully the real situation, however, the catastrophe was horrible and even now tremendous work has to be done. Our committee has been able to raise money through games, dramas, etc. .... Now I realize from the humanitarian view point the importance of my little knowledge from Miss Cole and our United Evangelical Church in this kind of work."

Mr. Jose Sto. Domingo, B.S.S.T. '33, visited the College on September 27, 1933. Mr. Sto. Domingo is at present employed as chemist in the Hind Sugar Co. at Manaoag, Pangasinan. He recently resigned from the Paniqui Sugar Mills to accept his present post.

Mr. Ramon K. Habaluyas, '19 is superintendent of fabrication in the Philippine Refining Co. at Malabon, and Mr. Eusebio A. Bataclan '24 is assistant superintendent.

Mr. Atanacio Carandang of the Calamba Sugar Estate visited the Campus on October 2, 1933 asking for information concerning the control of anthracnose disease of mango and of *Aeginetia indica* of sugar cane. Mr. Carandang said that the anthracnose disease of mango is quite prevalent in the mango groves on the estate.

Mr. Filemon Leus, '25, an employee in the Calamba Sugar Estate in charge of coconuts recently consulted the Department of Plant Pathology about the control of the bleeding disease of coconut.

The Agronomy 18 Class (Elements of Horticulture) under Mr. Ambrosio V. San Pedro went to Manila on September 27, 1933. They visited Bureau of Plant Industry at Singalong, Manila; Regino Fermin's flower garden and the Miyasaki Flower Gardens at Singalong; Chinese vegetable gardens in Paco; The Quiapo Market; Ah Gong and Sons Grocery Store in Quiapo; Metropolitan Flower Stall; International Cold Stores in Echague; Washington Grocery Store in Echague; Dulong Bayan Market, Azcarraga; Divisoria Market; Binondo Flower market; and the Cementerio del Norte. The definite objects were to obtain first hand information on how fruits, vegetables and flowers were prepared and offered for sale, and to observe the cultural practices of the Chinese gardeners. In the Bureau of Plant Industry, exhibits and demonstrations of vegetable and fruit canning, preparation of specimens for museum purposes, concentration of sirups, sterilization of preserves, pickling, preparation of *nata de piña*, rice flour, etc. were shown the students by Doctor Adriano. The students were also shown around the propagation station of the Bureau.

The Plant Breeding Division of this College is starting its crossing program for the season. This program will include a survey

of all flowering sugar cane varieties grown or found growing in various places in this locality, that is, from the shore of Laguna de Bay to Mount Maquiling, where cane varieties flower at different dates.

The thirteenth annual observance of Loyalty Day, October 10, has passed into history. The only flaw in what would otherwise have been a perfect day, complete and whole, was the weather. The rain was not torrential, but it was abundant most of the day, the heaviest and wettest falling during the parade. But with true Los Baños grit not a unit failed to be in line. And it was a fine display of what the College does and thinks. Department Agricultural Education including Rural High School unit was awarded first place; Department of Agronomy, second place; and honorable mention for Department of Animal Husbandry including Ranchers Club.

Governor General Murphy, the speaker for the day spoke with forceful eloquence on loyalty in life. He emphasized that there can be no loyalty without deep conviction and sincere devotion to ideals. "Great cathedrals were built because of deep conviction and loyalty in execution." True loyalty cannot be just for special occasions; it is for each day. Nor does true loyalty mean loyalty to one in power or to a political party. Loyalty is higher than an executive or a party. It is standing by one's convictions, being true to one's ideals. It was an address that will and should abide in the souls of those who heard.

The tennis and basketball games in the afternoon between College teams and teams from University of Santo Tomas resulted in victory for the visiting team.

The program and the games were in Baker Memorial Hall.

The dance for faculty, students, alumni and invited guests in the College Auditorium, weather preventing the use of the Circle, proved a popular innovation for Loyalty Day evening. An interesting feature of the evening was the Camp Claudio reminiscences by P. N. G. Veteran, Dr. D. Villadolid.

Effort was made this year to make Loyalty Day our Home Coming Day. As a matter of record, a register was open at Baker Hall for registration of alumni, former faculty members and former students. The registration was 34 Alumni, 8 former students and 3 former faculty members (not alumni), these were Dean Copeland, Professor Hester, and Professor Cuzner.

May these numbers increase each year!

The Secretary of the College of Agriculture reports the following students as graduating in October.

For the degree of Bachelor of Agriculture:

(1) Daniel M. Buñag (2) Napoleon A. Danao
3. Victoriano J. Madrid

For the degree of Bachelor of Science in Agriculture:

(1) Miguel G. Alba	(7) Bartolome P. Javier
(2) Gabino C. Arriola	(8) Julito Marcos
(3) Engracio Basio, B.Agr. '31	(9) Donato G. Dalupang
(4) Porfirio R. Carandang	(10) Sotero P. Penuliar
(5) Ricardo T. Marfori, B.Agr. '30	(11) Bernardo C. Sabalburo [1]
(6) Maximino S. Cortez	(12) Pantaleon H. de Los Reyes

For the degree of Bachelor of Science in Sugar Technology:

Virgilio C. Bustos

[1] Completed simultaneously all the requirements in the 6-year General Curriculum leading to the degree of B.Agr., and the Supplementary Curriculum leading to the degree of B.S.A.

FARMING IN BUKIDNON

As Bukidnon is the "pampas," the "cowboy west" of the Philippines, the word "ranching" naturally slides into place in this title but it was pushed aside for the good plain word "farming." The word "ranching" conjures up romance with many facets, while "farming" is without conjuring power; it keeps close to the ground among facts. But romance on the ranch is in the limbo of the past. The wide spaces where the winds swept free are no more. Science

Fig. 1.—Mr. and Mrs. Florentino Cruz and their four children in front of their home on Cruz Stock Farm. The two boys standing at back are Manobo servants. (The Manobo is the pagan hill tribe of Bukidnon.)

and her handmaiden, Invention have shriveled them up. And the dun colored utilitarian khaki has shoved the bright colored ornamented trappings of the ranchman into the silver screen studio. The gay romantic days of the ranch are gone. Today, we farm.

This College has a personal interest in the Bukidnon farmers for some of our graduates are so listed and others are getting experience as employees on farms and as teachers in the farm schools

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[1] General contribution from the College of Agriculture, No. 369.

of the province. And we hope they are hoarding earnings for future capital as Bukidnon farmers.

Our pioneer Bukidnon farmer is Mr. Florentino Cruz, B.Agr., '16 and Master Farmer in '23. It was a letter to Dean Gonzalez from Mr. Cruz, owner and proprietor of Cruz Stock Farm, that was the immediate impelling cause of this brief article or rather note on Bukidnon farming.

There is a tradition in the College that when Florentino Cruz had paid his first registration fees he had two pesos left as his sole money wealth. He supported himself through his College course and when he received his diploma, tradition further says, he had a sav-

Fig. 2.—Part of the main grade herd of 500 head which includes 100 pure breed Indian cattle. The animals have been driven into the "catching corral." Obviously, Stockman Cruz (on horseback) is on friendly terms with his cattle.

ings account of a hundred or more times two pesos. Thrift and a cannie sense of how to make the centavo grow into a peso was one of Nature's gifts to Master Farmer Cruz.

Before he became an independent stock farmer, Mr. Cruz accumulated experience and capital at Government Experiment Stations and as manager of the Nellore Ranch, one of the early private cattle ranches in Bukidnon. He says in his letter that he believes that if a man will "work honestly hard and try his best to save little by little he can start and succeed in the agricultural business."

Mr. Cruz is a consistent preacher of the maxim, "A penny saved is a pound earned," for he follows it with a devotion and an intelligence that would please Poor Richard could he observe it. "Waste

not, want not" is no less observed. A stockman guest on the Cruz Stock Farm tells that the owner will not tolerate neglect of the most unpromising animal although to do so is not uncommon on the Bukidnon stock farms. But, says Farmer Cruz, there will be a little profit in the animal. And as with the animals, so with other things on the farm. In practice, though probably it is not a lettered motto on his desk, Mr. Cruz follows the Scotch maxim, "Many a mickle makes a muckle."

In the days when Cruz was on the College roster there was no College song with the ringing, "Agriculture, College dear, devoted sons we'll ever be," but he surely qualifies as a "devoted son." And

Fig. 3.—A peanut field on Cruz Stock Farm. In the background, the Cruz residence and rice and corn granary. The peanut vines make excellent cattle forage.

the passing years have not cooled his ardor. A member of the faculty who was a guest for several days on Cruz Stock Farm tells how his host in showing him about pointed out the ways he was trying to make his home place look like the Campus in his College days. His orange orchard he wanted to place so it would remind him of the Agronomy orchard. He wanted Los Baños Cantonese chickens, not because they were good, but because they were a College product, and so on. This sentiment—and a beautiful one it is—calls to mind the thousands of pioneers in other countries who with much trouble take with them slips from the lilac bush by the home gate and from the rosebush by the front door, and seed of the favorite apple, and acorns from the favorite oak tree that they

might have a touch of home in the new raw land. Would that a "Big Bagtican" would rear its splendid crown on Cruz Stock Farm!

Among the photographs inclosed by Mr. Cruz which space does not permit reproducing is one showing his herd of 300 or more growing beef steers with himself and a herdsman in their midst on horseback, but without poncho, serape or lariat, just khaki shirt and trousers, neither rich nor gaudy, but apparel proclaiming the stock farmer of today not the ranchman of yesterday. Farmer Cruz makes a great point of having his cattle tame by personal contact; one means is through the regular salting. He tells in his letter that as when he was a student laborer in the College he could

Fig. 4.—Tenant families on Cruz Stock Farm; (*a*) Mr. and Mrs. Cruz. The house was the first Cruz residence. The buildings in background are cogon stables for riding horses and work steers.

always gather the chickens around him by feeding them white ants, so he gathers his different herds around him with salt. Another photograph shows his Barato grade herd of over 600 head. He writes that he gives careful consideration to his selection for his fundamental breeding stock. Another photograph shows a herd of 65 work steers "which are waiting work steer buyers from Negros Province." The unbroken steers, selected carefully as having good characteristics for draft animals, are turned over to his Ilocano tenants to be trained to work pulling the Disco and Vargas plows or the single plow. When well broken they are put on sale in the herd of work steers.

The crops of corn, rice, peanuts, vegetables raised by the tenants with these steers as cultivation power provide supplies for the farm and home and the practice illustrates the common sense thrift of Mr. Cruz.

Another photograph shows his mestizo Arabian horse herd. Out of this herd two race horses, Tenant and Scout, have made names as winners on the Manila race track. The note on the photograph states that there are six yearling colts in this herd being prepared for Manila racing stables.

Altogether, writes Mr. Cruz, he has about 1,800 head of cattle, horses and water buffaloes on his farm or ranch. In addition to his own land he rents about 3,000 hectares of grazing land from the Bureau of Forestry.

The photographs sent include one of extensive corn fields, another one shows a bountiful rice harvest. Farmer Cruz writes that many locust campaigners of the Bureau of Plant Industry were surprised that his crops were untouched by this enemy of farmers. But Lady Luck was with him and has continued to linger around his planted fields for the next crop.

Mr. Cruz closes his letter thus: "I am feeling happy because I am independent and nobody has the right to command me and every improvement I shall make on my ranch belongs to me and it will surely support and protect me in my old age. I own a Superfex refrigerator and a radio for the health and happiness of my family in this isolated and lonely place. I never thought that I would own such things."

The wireless, the radio, the railroad, the motor car, the speedships, the airplane, all shrinkers of space. The electric power, the tractor, the refrigerator,—and the tireless laboratory hermit, the researcher,—all bearers of priceless, peerless gifts to the ranchman. But all shrinkers of space and bearers of gifts are destroyers of the romance of the ranch of yesterday. Yes, but creators of the farm of today. A dull drab place, without color, without romance? No, but it is romance of a new era, requiring a new inner vision to see and a new concept to express.

EMMA S. YULE
Of the Department of English

Be the path and work of Life for thee
Through hidden vale or by far mountain height,
Know thou with vision clear to see,
That only in thy Soul is Life's measure full and right.

CHARLES FULLER BAKER

HARMFUL EFFECTS UPON YOUNG RICE AND MAIZE PLANTS OF RICE STRAW WHEN ADDED TO CLAY LOAM SOIL IN POTS [1]

R. B. ESPINO AND F. T. PANTALEON
Of the Department of Plant Physiology

WITH NINE TEXT FIGURES

INTRODUCTION

The harmful effects upon plants of straw when added to soil was early recognized. Several investigators have reported results of studies made on the subject, but we know of none in the Philippines, although it is a common practice of rice growers in this country to plow under weeds, rice straw, maize stalks, and other plant waste in preparing the field for rice, maize, or other crops. The effects on the growth and yields of rice plants of burying weed plants in the soil in pots were reported by Peralta (1931). But whether burying rice straw in the field *immediately* before planting rice or maize is beneficial or harmful to these crop plants is yet not definitely known, under the soil and climatic conditions obtaining in the Philippines. The occasional rather low yields of corn, or of rice when the latter is grown under upland conditions, might be suspected, at least in part, as being due to the planting of the crop plant *immediately* or soon after the rice straw has been plowed under. Conversely, the apparent good stand and high yield of rice might also be due to the planting being made after the rice straw has been allowed to decompose quite thoroughly. In either case, it would appear to be of interest to make the present study.

Review of literature

A careful study of available literature on the subject revealed the fact that most of the studies dealt with the effects of straw on the biological soil processes.

[1] Experiment Station contribution No. 920.

Read before the Los Baños Biological Club at the meeting held on July 20, 1933. Received for publication August 25, 1933.

Murray (1921) employing wheat straw in his studies arrived at the conclusion that:

> Straw applied to the soil stimulates the reproduction of bacteria. The bacteria use the straw as a source of carbon and use the nitrates (or in some cases ammonium sulfate) as a source of nitrogen. The nitrates are transformed to organic nitrogenous material and for the time being are lost as available plant-food. The intensity of the reaction depends upon the amount of straw.

Martin (1925) also found that, in general, the addition of straw to the soil caused a decrease in the amount of nitrates accumulating in the soil, and that the larger the application, the greater was the decrease in soil nitrates. He also observed that the depressed crop yield was proportional to the nitrate decrease. However, after allowing the straw to decompose for a period of twelve months, its harmful effect upon nitrification was found to have diminished.

Other workers who contributed more or less directly to the literature of the present study, were Pfeiffer *et al* (1909) who noted similar harmful effects from the application of wheat straw. Waksman (1924) suggested the idea that the straw was being used by the bacteria as a source of carbon. He suggested further that whatever nitrogen was available was utilized for the building of the bacterial protoplasm. Thus, he claimed that the nitrogen was lost as available plant food nutrient. Von May (1914) reported that "the availability of organically combined nitrogen was depressed by the presence of a nitrogen-free organic substance", as in the case of straw. He suggested that the loss in available nitrogen was due to the appropriation of the soluble nitrogen by micro-organisms which used the nitrogen-free substance as source of energy.

The depressive effects of application of straw on the crop itself was reported by Collison and Conn (1922). Stormer (1911) made a similar report and found that the finer the straw the smaller was the yield. However, Collison and Conn found that addition of carbon bisulfide to the soil to which straw had been added doubled the yield of the crop. This result seemed to suggest that micro-organisms were concerned. With the addition of ammonium sulfate, the harmful effects of the straw on buckwheat and mustard were overcome (Stutzer, 1907). Chirikov and Shmuck (1913) reported that the addition of calcium carbonate with the straw decreased the injurious effect of the latter but did not overcome it. The authors contended that the diminished yield was not due to denitrification in the strict sense, but that nitrates were converted into insoluble nitrogen compounds which were less assimilable by the plants.

From pot experiments on mustard and buckwheat, Bischoff (1914) observed that on a sandy soil the use of straw was almost always followed by a decrease in the yield of dry matter and of nitrogen. The harmful effect, however, was less when sodium nitrate was added. On clayey soils the use of straw was not always depressive to yield. He observed that late application of straw caused the greatest decrease in yield, if sodium nitrate was not added to the soil.

Object of this study

The object of the present study was to determine the relative effects upon *young* rice and maize plants of adding rice straw, rice straw ash, or both straw and ash to clay loam soil in pots, with special attention to the conditions of growth of young rice plants as influenced by varying the amount or the states of decomposition of the straw used.

Time and place of this study

This study was carried out in pots in the experimental yard of the Department of Plant Physiology during the second semester of the academic year, 1930-1931.

MATERIALS, CULTURES, AND RESULTS

The plants

Most of the plants used in this study were young rice plants but a few young maize plants were also used. These plants were started from seeds which were directly sown in earthen pots. Four seeds were sown in each pot; when about three centimeters high, plants of apparently uniform stand were selected, two plants in each pot. The rest of the plants were pulled up. In certain sets of cultures three instead of two young plants were allowed to grow in each pot.

The soil

Clay loam soil was used as the solid medium. It was collected from the experimental plots of the Department of Plant Physiology, pulverized, sieved, and thoroughly mixed, and 4.5 kgm. were put in each pot. In the first sets of cultures, the soil was used unsterilized. In the last two sets of cultures, however, the soil was partially sterilized by heat in a simple way. It was placed on a wide flat sheet of iron that was over an open fire. This sterilization could be only partial; it was done with the purpose of killing as many of the soil bacteria and other soil microörganisms as possible by so crude a method.

The rice straw

Fresh, but not green, rice straw was used in this study. The straw, chopped into pieces about half a centimeter long, was added to the soil in pots either in varying amounts or at different times. Ash was prepared from straw; 25 grams of straw produced about 7 grams of ash.

The cultures and results

Four or five main sets of cultures were tried. They may be considered as representing different problems, and may be described as follows:

Problem 1. To determine the relative effects upon the growth and development of young maize plant, of adding rice straw, rice straw ash, or both, to clay loam soil in pots.

To work out this problem, the following culture media were tested. The clay loam soil was not sterilized:

Culture I contained 4.5 kgm. of soil.
Culture II contained 4.5 kgm. of soil and 14 grams of straw ash.
Culture III contained 4.5 kgm. of soil and 7 grams of straw ash and 25 grams of straw.
Culture IV contained 4.5 kgm. of soil and 50 grams of straw.

Two similar sets of cultures were employed; each set was run in duplicate. Each pot contained two young maize plants. The experiment was started on December 18, 1930 and the plants were harvested on January 20, 1931. The experimental data obtained, in relative values, are shown in table 1; columns *a* and *b* each contain the average data for the duplicate cultures. The plants that yielded the data under column *b* were photographed at the time of harvest (see fig. 1).

TABLE 1

Yields[a] of tops and roots of young maize plants, plainly showing harmful effects upon the plants of rice straw when added to soil

CULTURE NO.	WEIGHT OF DRY TOPS		WEIGHT OF DRY ROOTS		WEIGHT OF DRY TOPS AND ROOTS		AVERAGE[b]
	a	b	a	b	a	b	
I	100 (2.502 grams)	100 (3.235 grams)	100 (0.974 gram)	100 (1.476 grams)	100 (3.476 grams)	100 (4.71 grams)	100
II	72	71	71	66	72	69	70
III	22	46	42	61	27	51	42
IV	18	36	27	46	20	39	31

[a] The data in the table are averages in relative values. The yield value shown in the table from culture I under each criterion was arbitrarily taken as 100. The other yield values were reduced relatively.

[b] Average of the relative values.

Problem 2. To determine the relative effects upon the growth and development of young rice plant, of adding rice straw or rice straw ash, or both, to clay loam soil in pots.

Culture media similar to those used in problem 1 were also tried on young rice plants. Four similar sets of cultures were employed, each set was run in duplicate. The cultures were run by members of our plant nutrition class [2] under our direction and supervision. They were started on December 18, 1930 and harvested on January 27, 1931. The data on the yields of top and of root are shown as averages under columns *a*, *b*, *c*, and *d* in table 2.

To correct acidity, if the soil turned acid as a result of the treatments, the cultures under column *a*, each received, in addition to the standard treatments, 2 grams of lime. The other cultures, such as those the results of which are under columns *b*, *c*, and *d* received no lime. At the time of harvest the first and the fourth sets of cultures, the data of which are shown under columns *a* and *d*, respectively, in table 2, were photographed (see fig. 2 and 3).

TABLE 2

Yields [a] of tops and roots of young rice plants, plainly showing effects upon the plants of rice straw when added to soil in pots

CULTURE NO.	WEIGHT OF DRY TOPS				WEIGHT OF DRY ROOTS				AVERAGE
	a [b]	b	c	d	a [b]	b	c	d	
I	100 (0.877 gram)	100 (1.081 grams)	100 (1.402 grams)	100 (1.202 grams)	100 (0.342 gram)	100 (0.467 gram)	100 (0.584 gram)	100 (0.418 gram)	100
II	87	75	56	89	74	73	44	90	74
III	13	26	45	37	15	28	38	36	30
IV	9	7	10	17	11	6	8	17	11

[a] The data are in relative values; see table 1 for explanation. The data under *a*, *b*, *c* and *d* are averages and were obtained from experiments conducted at different times.

[b] Except culture I, the cultures in this set were supplied with 2 grams of lime each. Cultures sets *b*, *c* and *d* received no lime.

Problem 3. To determine whether or not the harmful effeets would appear again if the same set of culture media were once more planted to young rice plants.

Having observed from the preceding cultures that rice straw when added to the soil was harmful to young rice plants, at least during the first forty-two days of growth, this problem was under-

[2] Messrs. Francisco Helardo, Artemio Malabayabas, and Ambrosio San Pedro.

taken. Two sets of culture media, previously planted to young rice plants for forty-two days, were again planted to young rice plants by members of our plant nutrition class under our direct supervision. Each culture was run in duplicate. The cultures were started on December 23, 1930 and the plants were harvested on February 2, 1931. Before harvesting, one of the two sets of cultures was photographed (see fig. 4). The yields of tops, of roots, or both top and root, as averages, are recorded in table 3.

TABLE 3

Yields[a] of tops and roots of young rice plants, showing again harmful effects of rice straw upon the plants even in the second planting

CULTURE NO.	WEIGHT OF DRY TOPS		WEIGHT OF DRY ROOTS		WEIGHT OF DRY TOPS AND ROOTS	
	a	b	a	b	a	b
I	100 (0.527 gram)	100 (0.793 gram)	100 (0.161 gram)	100 (0.222 gram)	100 (0.688 gram)	100 (1.015 grams)
II	158	122	159	111	159	119
III	134	114	125	74	132	106
IV	37	41	16	23	32	37

[a] The data are in relative values; see table 1 for explanation.

Problem 4. To determine whether or not the harmful effects upon the young rice plants of rice straw when added to clay loam soil were due to acidity, or to an increase in pH concentration in the soil.

Samples of the different culture media were collected from each culture in a set after the young rice plants had been harvested. With the kind cooperation of Dr. Dionisio I. Aquino of the Soils Department, two sets of tests for acidity were made, employing Trenel's acidometer; the results are given in table 4.

TABLE 4

Showing the pH values of the different culture media. The pH value of each culture medium was determined twice, a and b, by means of Trenel's acidometer

CULTURE MEDIA	pH VALUE	
	a	b
I. Soil alone (4.5 kgm.)	6.54	6.61
II. Soil (4.5 kgm.) + ash (14 grams)	6.68	6.76
III. Soil (4.5 kgm.) + ash (7 grams) + straw (25 grams)	6.86	6.73
IV. Soil (4.5 kgm.) + straw (50 grams)	6.78	6.87

Problem 5. To determine the comparative harmful effects upon young rice plants of rice straw when added in varying amounts to clay loam soil in pots.

To attack the experimental side of this problem, cultures with young rice plants employing the following culture media were made:

Culture I contained 4.5 kgm. of soil.
Culture II contained 4.5 kgm. of soil and 10 grams of straw.
Culture III contained 4.5 kgm. of soil and 20 grams of straw.
Culture IV contained 4.5 kgm. of soil and 30 grams of straw.
Culture V contained 4.5 kgm. of soil and 40 grams of straw.
Culture VI contained 4.5 kgm. of soil and 50 grams of straw.

Each culture contained three young rice plants and was run in duplicate. Two sets of cultures were grown to an upland rice, variety Inintiw, and the third set was grown to a lowland rice, variety Ramai. The cultures were simultaneously started on December 18, 1930 and were harvested on January 27, 1931. The first and the third sets of cultures were photographed (see fig. 5 and 6). The cultures were harvested and the experimental data obtained are given in table 5, in which the data as averages under columns *a* and *b* were from the upland rice, and those under column *c*, also as averages, from the lowland variety. The lowland rice was grown in pots with the soil submerged in water.

TABLE 5

Yields[a] of tops and roots of young rice plants, plainly showing harmful effects upon the plants of rice straw when added to clay loam soil in pots

CULTURE NO.	WEIGHT OF DRY TOPS			WEIGHT OF DRY ROOTS			WEIGHT OF DRY TOPS AND ROOTS		
	a	b	c[b]	a	b	c[b]	a	b	c[b]
I	100 (0.716 gram)	100 (0.567 gram)	100 (1.264 grams)	100 (0.316 gram)	100 (0.380 gram)	100 (0.449 gram)	100 (1.032 grams)	100 (0.947 gram)	100 (1.713 grams)
II	64	90	68	58	47	59	62	76	66
III	34	42	43	28	24	47	31	35	44
IV	15	17	29	9	13	27	13	15	28
V	10	12	22	8	9	24	10	11	22
VI	9	10	16	5	8	16	8	9	16

[a] The data are in relative values, see table 1 for explanation.
[b] From rice Ramai, a lowland variety, the plants were grown in pots under lowland conditions.

Problem 6. To determine the relative harmful effects upon young rice plants of rice straw when added to clay loam soil in pots at different times.

To work out this problem, two sets of cultures were conducted in which the following culture media were employed:

Culture I, 25 grams of straw were added to soil 105 days before planting.
Culture II, 25 grams of straw were added to soil 90 days before planting.
Culture III, 25 grams of straw were added to soil 75 days before planting.
Culture IV, 25 grams of straw were added to soil 60 days before planting.
Culture V, 25 grams of straw were added to soil 45 days before planting.
Culture VI, 25 grams of straw were added to soil 30 days before planting.
Culture VII, 25 grams of straw were added to soil 15 days before planting.
Culture VIII, 25 grams of straw were added to soil at the time of planting.
Culture IX, no straw was added to soil.

Both sets of cultures were simultaneously started on December 7, 1931, but the plants in one set were harvested on January 30, 1932 and those from the other set, a week later. On January 29, 1932, the cultures in the first set were photographed (see fig. 7). The experimental data from both sets of cultures are given in table 6.

TABLE 6

Showing the data obtained from the two sets of cultures to which rice straw was added to soil at different times at the rate of 25 grams per culture

CULTURE NO.	NUMBER OF DAYS STRAW HAD BEEN IN SOIL IN POTS BEFORE PLANTING	WEIGHT OF DRY TOPS AND ROOTS				AVERAGE OF RELATIVE VALUES
		Set *a*		Set *b*		
		Actual value	Relative [a] value	Actual value	Relative [a] value	
		grams		*grams*		
I	105	1.557	172	2.460	179	175
II	90	1.041	115	1.649	120	117
III	75	1.071	118	1.371	100	109
IV	60	0.359	40	0.904	66	53
V	45	0.312	34	0.398	29	32
VI	30	0.171	19	0.269	20	20
VII	15	0.316	35	0.324	24	29
VIII	Straw added at time of planting	0.157	17	0.148	10	14
IX	No straw	0.908	100	1.373	100	100

[a] See foot-note, table 1. The actual value from culture IX was arbitrarily taken as 100.

Problem 7. To determine whether or not partial sterilization of the soil by heat would increase or decrease the harmful effects upon young rice plants of rice straw when added to clay loam soil in pots.

To contribute to the solution of this problem, two sets of cultures were employed. One set consisted of four duplicate cultures and received the following treatments:

Culture I contained partially sterilized soil to which no straw was added.
Culture II contained partially sterilized soil to which were added 50 grams of rice straw.

Culture III contained unsterilized soil to which no straw was added.
Culture IV contained unsterilized soil to which were added 50 grams of rice straw.

The cultures were run for about forty days and were photographed on January 12, 1931, (see fig. 8). No other experimental data were gathered.

The other set of cultures consisted of the following:

Culture I	contained unsterilized soil only.
Culture II	contained unsterilized soil and 10 grams of rice straw.
Culture III	contained unsterilized soil and 30 grams of rice straw.
Culture IV	contained unsterilized soil and 50 grams of rice straw.
Culture V	contained partially sterilized soil only.
Culture VI	contained partially sterilized soil and 10 grams of rice straw.
Culture VII	contained partially sterilized soil and 30 grams of rice straw.
Culture VIII	contained partially sterilized soil and 50 grams of rice straw.

Culture IX	contained partially sterilized soil.
Culture X	contained partially sterilized soil and 10 grams of rice straw.
Culture XI	contained partially sterilized soil and 30 grams of rice straw.
Culture XII	contained partially sterilized soil and 50 grams of rice straw.

Cultures I to IV, inclusive, received rain water whenever it rained and unboiled very dilute extract from clay loam soil. Cultures V to VIII, inclusive, received rain water whenever it rained and very dilute unboiled soil extract. Cultures IX to XII, inclusive, received rain water whenever it rained and very dilute boiled soil extract. Soil extract was used so that soil bacteria could be introduced in the partially sterilized culture media whenever unboiled soil extract was used. Soil extract was boiled and was used in the other cultures so that no bacteria, or at least, very few, would be introduced in the soil with the soil extract.

In adding soil extract to all the cultures in this set, it was expected that the same amounts of soil nutrients were added to all the cultures, so that any variations in the growth of the plant in the different cultures could not be due to the uneven addition of the soil extract.

When about forty days old, the young rice plants in the different cultures in the set were photographed (see fig. 9). No other experimental data were gathered.

DISCUSSION OF RESULTS

Problem young rice plant at different time

In the present study the plants, rice and maize, were grown in earthen pots. Hence, none of the plants in the cultures ...ght to complete maturity to produce grains. How-

ever, the results are expected to be of value because of the known fact that the early good growth and development of a plant is conducive to good growth and development in the later life of the same plant. The converse is known to be true, also.

Effects upon young maize plant of rice straw, rice straw ash, or of both, when added to clay loam soil

Examination of table 1 shows that under the criteria of results employed, culture I was the best and culture IV, the poorest. In term of averages of the relative values of the results obtained, culture IV was about 69 per cent inferior to, or poorer than, culture I.

Fig. 1.—Young maize plants grown in pots. Culture 1 contained clay loam soil only; 2, contained soil and rice straw ash; 3, contained soil, rice straw ash, and rice straw; and 4, contained soil and rice straw.

But culture IV, in addition to the same kind and the same amount of soil that culture I contained, had only 25 grams of rice straw. Therefore, the decidedly poor results and poor stand of the plants (see fig. 1) in culture IV was in all probability due to the harmful effects of the 25 grams of rice straw that this culture received.

However, when the rice straw was reduced to ash and this was used instead of the straw, the harmful effects usually obtained from the straw were greatly diminished (see table 1 and fig. 1). But, culture II which received only ash, although about 40 per cent superior to culture IV, was found to be about 30 per cent inferior to culture I. Hence, it appears that even the rice straw ash, at the rate that

it was used in this experiment, was found also to have decreased the growth and development of young maize plant.

A combination of rice straw and rice straw ash in clay loam soil in culture III was likewise rather harmful to the young maize plant. This statement is borne out by the data in table 1 and by figure 1. The plants in culture III were only slightly better developed than those in culture IV, and certainly were not half as poor as those grown in the clay loam soil only.

In conclusion, therefore, the presence of rice straw, rice straw ash, or of both, in clay loam soil in pots was harmful to young maize plant. The addition of rice straw was decidedly harmful to the young plant.

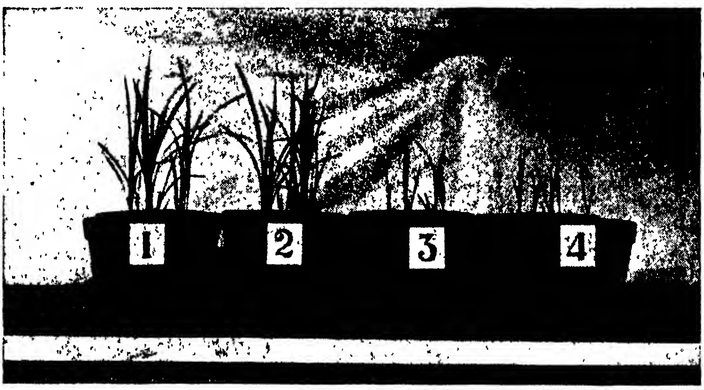

Fig. 2.—Young rice plants grown in pots. Culture 1 contained clay loam soil only; 2, contained soil and rice straw ash; 3, contained soil, rice straw ash, and rice straw; and 4, contained soil and rice straw.

Effects upon young rice plant of rice straw, rice straw ash, or of both, when added to clay loam soil

By the data in table 2 and the illustrations in figures 2 and 3, we see the harmful effects on young rice plants, of rice straw when added to clay loam soil in pots. In term of averages of the relative values shown in table 2, culture IV, in which rice straw was added to the soil, produced only about 11 per cent as much dry matter of the young plants as the plants produced in culture I. Culture I which had only soil produced young rice plants about 25 per cent better than those produced in culture II in which the plants were supplied with rice straw ash in the soil, and about 70 per cent better

than those in culture III in which rice straw and ash were added to the soil.

Therefore, the presence of rice straw, rice straw ash or of both, in clay loam soil in pots was also harmful to the young rice plant. The amount of harm appeared to be particularly severe in the cultures to which only rice straw was added.

The data in table 2 also show that the addition of lime to cultures II, III, and IV under column *a* did not improve the stand of the young rice plants. It may, therefore, be suspected that the apparent harm to the plants of the various treatments was due to a cause or causes other than acidity of the culture media.

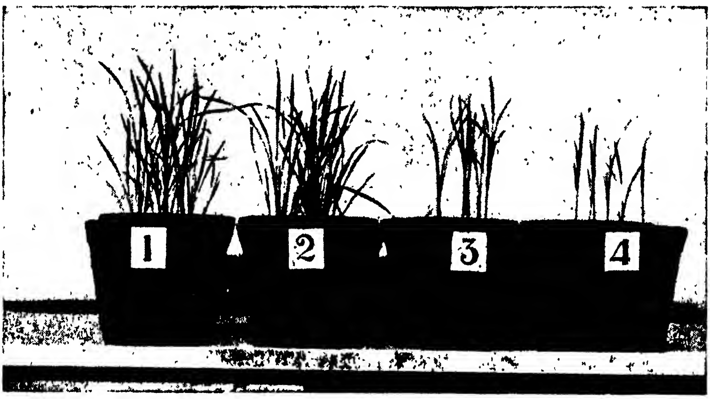

Fig. 3.—A repetition of cultures in figure 2.

Harmful effects of rice straw exhibited during the second planting

Suspecting that during the first thirty or forty days the rice straw, the rice straw ash, or both had not been sufficiently converted into available plant nutrients to make it nutritively valuable to the young rice plant, a second planting in each set of cultures was made. Evidently, our suspicion was not without foundation. For, when the second thirty or forty day plantings were harvested, different sets of results were obtained (see fig. 4).

Table 3 shows that culture II was the best in the lot. It shows also that, except in one instance, culture III, although slightly inferior to culture II, was better than culture I, which always produced the best developed plants in the first thirty or forty day plant-

ing. In other words, cultures II and III later proved to be nutritively better than either culture I or culture IV. The improvement was apparently due to the use of ash, because when the culture was supplied only with the rice straw, the yields of dry matter of the young rice plants were still inferior to those obtained from culture I, which was supplied with the clay loam soil only. However, in the second set, or later planting, the young plants produced in culture IV were much better developed than those grown in the same culture medium during the first thirty or forty days.

Hence, it appears that the harmful effects upon the young rice plants of the rice straw, seemed to diminish as the state of decom-

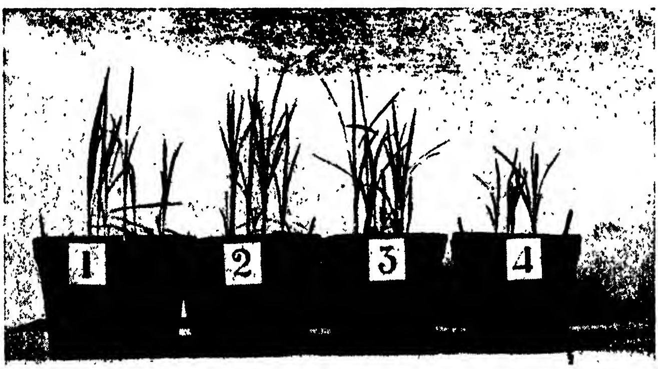

Fig. 4.—Young rice plants grown in pots. The culture media were similar to those in figures 2 and 3 but the plants in figure 4 were of the second planting, that is, the second time that the culture media were planted to rice.

position of the straw became more thorough, and the nutritive value of the ash seemed to increase with time.

Harmful effects of straw not due to increase in pH value

Table 4 shows that the pH values in the four types of culture media examined, ranged from 6.54 to 6.87 only. These figures show that there were rather low pH values in the culture media employed. In other words, the culture media used were just slightly acid, although rice straw was added to some of them. In fact, culture IV which had the poorest stand of the plants had pH values in the duplicate cultures of 6.78 in one and 6.87 in the other. These values approach the neutral point (pH 7) and should be favorable not only

to rice but to most field crop plants. This was not the case, however. Therefore, the harmful effects upon the young rice plants of rice straw when added to clay loam soil in pots were not from an increase in acidity, or pH value of the soil but to something else.

Comparative harmful effects upon young rice plant of rice straw when used in varying amounts

So far, in this study the straw has been tried only at the rate of 25 grams to a culture. This time, it was added to the soil in varying amounts, ranging from 10 to 50 grams. The results obtained show that the amount of harm done to the young rice plant increased with the amount of straw used (see table 5 and fig. 5 and 6). The results further show that none of the cultures (including those grown of a lowland rice variety Ramai under lowland conditions, see table 5 *c*) that received rice straw produced plants better developed than those grown in clay loam soil only without straw.

Fig. 5.—Young rice plants grown in pots in which rice straw was added to clay loam soil in varying amounts. Culture 1 contained 50 grams of rice straw, the largest amount tried; and culture 6 contained the least amount, 10 grams of rice straw.

Comparative harmful effects upon young rice plant of rice straw present in clay loam soil in varying states of decomposition

Before presenting the data obtained under this topic, it should be stated that the straw was added to the clay loam soil in the pots at intervals of fifteen days, and the soil or the soil and the straw contained in the pots was kept always wet—either with water from rain or from the faucet. Thus, one might expect that at the time

of planting the rice straw in the soil in the pots would be in varying or different states of decomposition. Evidently, that was the case. At the end of 60 or 75 days in the soil, the straw appeared to be thoroughly decomposed. But, at the end of 45, 30, or 15 days there was still straw in the pots. Of course, by the end of the first 15 days, that is, at the time of planting, the straw had just been added to the soil in pots.

Turning to table 6 and to figure 7, it will be seen that cultures I, II and III, each produced dry matter equal to, or greater than that from culture IX, to which no straw was added. On the other hand, none of the cultures IV, V, VI, VII, and VIII produced plants better developed than those in the "no straw" cultures.

From the foregoing observations, it appears that the rice straw when allowed to decompose in the soil for more than 75 days, not

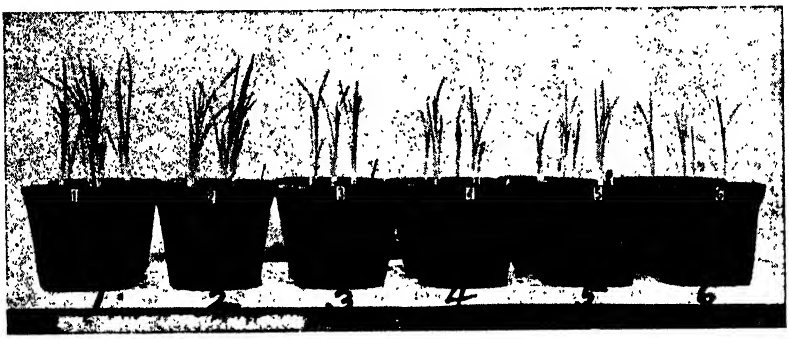

Fig. 6.—A repetition of cultures shown in figure 5.

only completely lost its harmful effects but even proved nutritive or stimulating to the growth and development of the young rice plant. In fact, in culture I in which the straw had been in the soil for 105 days before planting, the increase in dry matter over that from the "no straw" culture, averaged about 75 per cent.

Partial sterilization of soil eliminates the harmful effects of rice straw

As figure 8 shows, the plants in cultures I and II were quite similarly developed. Both cultures had partially sterilized (heated) soil, but culture I had no straw while culture II received 50 grams of straw at the time of planting. Evidently when the straw was added to partially sterilized soil, there were no harmful effects to the young rice plant. These effects appeared to have been neutralized

by heating the soil, or partial sterilization—or by something that was produced in the soil as a result of heating it.

On the other hand, culture III was better than culture IV with respect to the stand of the plant. The first received no straw, and the second was given 50 grams. Thus, the poorer stand of the plants in culture IV, probably, was due to the addition of the 50 grams of rice straw to that culture.

In figure 8, it is shown that the plants in cultures I and II were far better developed than those in cultures III and IV. But, the first two cultures had partially sterilized or heated soil; while the last two had the clay loam soil as from the field, not sterilized. The better stand of the plants in cultures I and II, in all probability, was due to the partial sterilization of the soil. Further reference to the

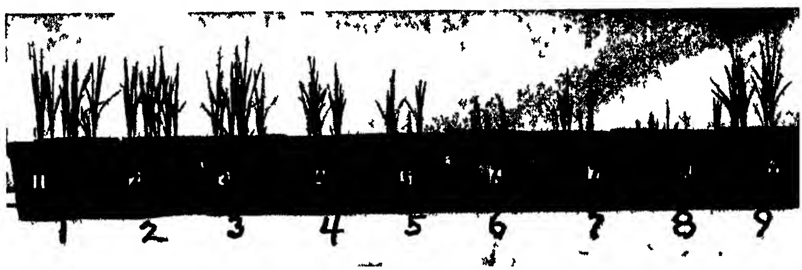

Fig. 7.—Young rice plants grown in clay loam soil in pots to which rice straw was added at different times For explanation, see "Problem 6."

probable beneficial effects derived from heating, or partial sterilization, will be made later.

In figure 9, cultures I to IV inclusive, had very much poorer stands of young rice plants than cultures V to XII, inclusive. As may be recalled, the soil in cultures I to IV was unsterilized, that is, not heated; while the soil in the rest of the cultures was heated, partially sterilized, at least. It may be concluded, then that the difference in the stands of the plants in the two sets of cultures—unsterilized and partially sterilized—may have been due to the heating of the soil.

Shown in figure 9, culture I which did not receive straw was the best. The plants in the three remaining cultures were poorly developed, stunted and chlorotic. The worst in the lot was culture IV, which received 50 grams of rice straw at the time of planting. In this culture, the plants hardly grew at all.

Cultures V to XII in figure 9 had partially sterilized soil. Expecting that heating, or partial sterilization might have killed all or almost all the micro-organisms in the soil, and suspecting that bacteria were, as suggested by the literature, directly or indirectly responsible for the apparent harmful effects upon the plant by the straw, a further cultural comparison was made. To introduce bacteria, cultures V to VIII, from time to time, were supplied with very dilute unboiled, or unsterilized soil extract. The introduction or the increase in the number of bacteria was expected to promote the harmful effects upon the plant when straw was present in the

Fig. 8.—Forty-day old rice plants. Cultures 1 and 2 contained partially sterilized soil; 1, no straw and 2, with 50 grams of straw. Cultures 3 and 4 contained unsterilized soil; 3, no straw and 4, with 50 grams of straw.

soil. This expectation was in accordance with the report of Murray (1921) that the "bacteria use the straw as a source of carbon and use the nitrates (or in some cases ammonium sulfate) as a source of nitrogen. On the other hand, to prevent the introduction of bacteria, cultures IX to XII, from time to time, were supplied with boiled, or sterilized dilute soil extract.

In spite of these precautionary treatments, and although no two cultures in this lot (cultures V to XII) had exactly the same culture media, the plants produced in the different cultures were ap-

parently equally well developed. From these results, the conclusion may be drawn that the apparent beneficial effects derived by the young rice plant from heated or partially sterilized clay loam soil was due not to the absence of bacteria, but to something else present in the soil.

Probable explanation of harmful effects upon young rice plant of rice straw added to soil

To determine the probable cause or causes of harmful effects upon young rice plant of rice straw in clay loam soil, a careful consideration of the data which have been just discussed together with the data contributed by the available literature on the subject should be of value and of interest.

The harmful effects upon the young rice plants of rice straw when added to unsterilized clay loam soil were exhibited as causing a stunting of the growth of the plants and producing chlorotic

Fig. 9.—Forty-day old rice plants. For detailed description of the various treatments given, see "Problem 7."

leaves. Careful examinations of the culture media and of the plants grown therein revealed the absence of living "agencies hostile to plant growth", such as insect pests and fungous and bacterial diseases. Hence, the trouble was not of pathological nature.

Was it a case of the formation of poison, or of toxic substances in the soil? The answer is also in the negative. For, the soil in the pots was rather loose and was not water-logged either. It was well aërated and could not have possibly formed poisons, or substances sufficiently toxic to the young rice plants to harm them. Moreover, the pH value determinations revealed the fact that the culture media employed to which rice straw, rice straw ash, or both was added, were not too acidic. To be sure, these culture media were just approaching the neutral point and were slightly acidic. But, if the harmful effects were not due to insect pests and fungous and bacterial diseases nor to poisons, what could have been the cause or causes of the trouble?

To answer this question, it should be recalled that Collison and Conn (1922) found that addition of carbon bisulfide to the soil to which straw had been added doubled the yield of the crop. This result seemed to suggest that micro-organisms were concerned. Moreover, Murray (1921) reported that the addition of straw to the soil stimulated the reproduction of bacteria. Murray contended that the "bacteria used the straw as a source of carbon and used the nitrates (or in some cases ammonium sulfate) as a source of nitrogen." According to him, the nitrogen was then lost as available plant food, because the nitrates were transformed to organic nitrogenous material after they had been utilized by the bacteria. Waksman (1924) was also of the opinion that the straw was used by the bacteria as a source of carbon, and suggested that whatever nitrogen was available was utilized for the growth of the bacteria. Von May (1914) was also of this opinion.

However, Martin (1925) was not entirely of the same opinion. Although he also reported having observed a decrease in the amount of nitrates in the soil following the addition of straw, yet unlike the other authors, he was of the opinion that the decrease of nitrates in the soil occurred not because the bacteria had used this salt, but because the addition of straw produced deleterious effects upon nitrification. The exact nature of these effects upon nitrification appears not to be revealed clearly by the literature. The literature seems also vague as to the kinds of bacteria concerned and no bacterial count was made to substantiate the contention of Murray (1921). As it now stands, the problem of the cause or causes of the apparent harmful effects upon young rice plant of rice straw in clay loam soil has not as yet been solved conclusively by experiments; hence, not clearly understood.

Probable explanation of the elimination of the harmful effects upon young rice plants of rice straw when the soil used was previously heated or partially sterilized

To explain the probable cause or causes of the apparent beneficial effects which the young rice plants derived from heated or partially sterilized soil, would require consideration of available experimental data on the subject,—especially those gathered by other investigators.

The literature on the subject is rather extensive, but difficulties are met because of certain contradictory results reported by some investigators.

There are those who believed that the beneficial effects upon the plant derived from the partial sterilization by heat was due to the increase in bacterial numbers. Hall (1917) reported that heating soil to 60°C. or more caused first a fall then a rise in bacterial numbers. Coleman, Lint, and Kopeloff (1916) also found an increase in bacteria as a result of partial sterilization of soil. Marshall (1921) was also of the same opinion as to effects on bacterial population of the soil. But, none of these investigators specified the types or species of bacteria affected.

In considering the increase in bacterial numbers, Marshall (1921) may be quoted as follows:

> The fact that there is an increase in bacterial numbers and in consequence, enhanced fertility of the soil may not be due to the elimination of protozoa but may rather be ascribed to such effect of partial sterilization process as increase in available food for bacteria, rendering soil toxins insoluble, destroying bacteriotoxins, and acceleration of the biological processes.

Hall (1917) had another idea. He believed that the rise in bacterial numbers was accompanied by a marked increase in the rate of accumulation of ammonia.

Waksman and Starkey (1923) was also of the opinion that in partially sterilized soils ammonia accumulates, especially in those soils which are rich in organic matter. Maranion (1931) found that burning the soil brought about an increase in its nitrifying power and also an increase in nitrogen fixation, but the activity of the cellulose decomposing organisms seemed not affected materially.

Potter and Snyder (1918) contended that heating the soil caused an increase in soluble non-protein nitrogen, amino acid nitrogen, but that the nitrate contents remained about the same. Schreiner and Lathorp (1912) had a different idea. They reported that heating the soil resulted in the formation of such organic compounds, as, xanthine, hypoxanthine, guanine, cytosine, and irginine—all derived from nucleic acid and proteins, and reported to be beneficial to plants.

From the preceding extracts, it might be possible to get an explanation for the disappearance or elimination of the harmful effects upon the young rice plants of rice straw in soil when it had been partially sterilized by heat. To begin with, it should be recalled

that Collison and Conn (1922) found that addition of carbon bisulfide to the soil to which straw was added doubled the yield of the crop, indicating, as several writers claimed, that micro-organisms were concerned. In other words, addition of straw to the soil increased bacterial numbers. It is also stated in literature that partial sterilization of the soil results in an increase in bacterial population. Hence, the two types of treatment, addition of straw and partial sterilization of the soil, ought to increase the number of bacteria. And according to the explanation offered by Murray (1921) that the "bacteria used the straw as a source of carbon and used the nitrates (or in some cases ammonium sulfate) as a source of nitrogen" then the two kinds of treatment referred to ought to produce a poorer stand of the young rice plant. However, that was not the case in the present study. For, partial sterilization of the soil by heat produced well developed young rice plants, whether there was straw or no straw in the soil. In fact, the plants from the partially sterilized soil appeared several times better developed than those grown in the untreated soil. The leaves of the plants from the former cultures were darker green than those from the latter cultures. The plants from the treated cultures appeared as if they had been supplied with a rather liberal application of sulfate of ammonia.

For these reasons, it might be correct to suspect that the apparent disappearance or elimination of the harmful effects of the rice straw in partially sterilized soil was due, as contended by Hall (1917) and by Waksman and Starkey (1923), to the accumulation of ammonia. Maranion's (1931) findings that burning the soil brought about an increase in its nitrifying power and in nitrogen fixation, may also account for the excellent stand of the young rice plant, and in accord with the finding of Bischoff (1914) to the effect that the harmful effect was less when sodium nitrate was added to the soil. Stutzer (1907) found that with the addition of ammonium sulfate, the harmful effects of the straw to buckwheat and mustard were overcome.

SUMMARY OF CONCLUSIONS

1. The presence of rice straw, rice straw ash, or of both straw and ash in clay loam soil in pots was harmful to the growth and development of young rice and maize plants. The harm appeared to be particularly severe in the cultures to which only rice straw was added.

2. The harmful effects upon the growth and development of the young rice plant of rice straw in the soil increased with the amount of straw used. This finding was true with both Inintiw, an upland variety grown under upland conditions and Ramai, a lowland variety grown in water saturated soil in pots.

3. The harmful effect was not due to an increase in the acidity, or the pH value of the soil, and was not corrected by the addition of lime to the soil in pots.

4. Rice straw when allowed to decompose in the soil for more than 75 days before the rice was planted, not only completely lost its harmful effects, but even proved nutritive or stimulating to the growth and development of the young rice plant.

5. Literature expresses divergence of opinion as to the cause or causes of the harmful effects upon plants of straw present in the soil. Apparently the problem has not, as yet, been fully solved experimentally. The contention that the harmful effect is due to bacterial action and that "bacteria used the straw as a source of carbon and used the nitrates (or in some cases ammonium sulfate) as a source of nitrogen", should receive serious consideration.

6. When rice straw was added to soil partially sterilized by heat, its usual harmful effects on the young rice plant disappeared, and well developed plants were produced. The apparent disappearance or elimination of the harmful effects was due not to the absence of bacteria, but as suggested by the literature, to the accumulation of ammonia and to an increase in the nitrifying power and nitrogen fixation in the soil.

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SOAP MAKING ON THE FARM[1]

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Of the Department of Agronomy

WITH FIVE TEXT FIGURES

Economic conditions in the world have so reduced our exports of coconut products that our supply far exceeds the demand. The return to normalcy of our coconut market in the United States is doubtful because of the campaign of American farm organizations to restrict, if not entirely stop, the importation of Philippine copra and coconut oil into the United States. Facing this situation it becomes very important to increase, if possible, our local consumption of coconut oil. With this aim, the Department of Agronomy of the College of Agriculture has begun to use coconut oil made from nuts from its experimental trees for soap making, the principal object being to obtain information and data about the process with coconut oil as the fat ingredient.

Making soap is a simple matter. It is the manufacture of special soaps that has been the object of experimentation by chemists for many years. But all their interesting discoveries about soap manufacture with coconut oil as the fat are of little value to the Filipino farmers or others who wish to make a usable cleaning soap with the cheap coconut oil. What they want is a simple process given in clear directions that they can follow.

The aim of this brief circular is to give some directions about soap making simple enough that any man or woman with ordinary knowledge and experience by following them can make soap for home use or for limited sale. The circular was prepared also as a general answer to the numerous letters addressed to the Agronomy Department, many of them from owners of coconut trees, asking for information about soap making from coconut oil.

The method described in this circular, a home method it might be called, is the result of many trials. The soap obtained as a final product has proved satisfactory for washing clothes and for general

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cleaning. Although our method is far from perfect, nor is it wholly original, we hope that it will be of practical help, for farmers and others desirous of making soap at home.

MATERIALS AND UTENSILS NEEDED

The materials and utensils necessary for making soap by our method are: Commercial sodium hydroxide, sodium carbonate or sodium sulfate, wood ash lye, coconut oil, kettle or empty petroleum can for boiling the soap, stirring rod, and wooden form to mold the soap.

PREPARATION OF THE MATERIALS

Commercial sodium hydroxide. This chemical can be bought for 53 centavos a kilogram from wholesale druggists in Manila or

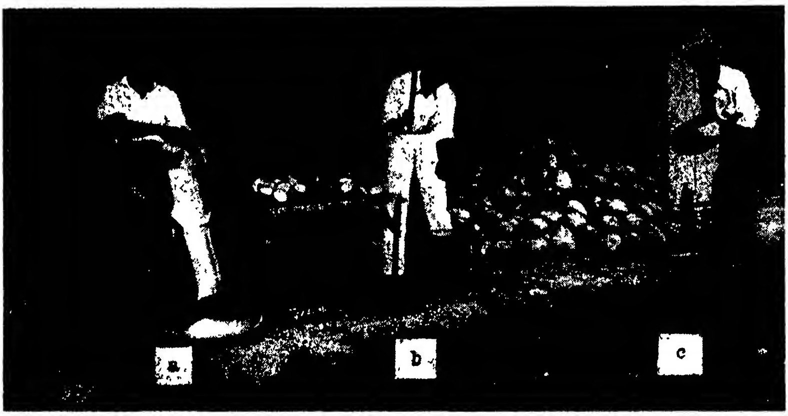

Fig. 1.—(*a*) Grating coconut meat with a revolving serrated knife; (*b*) breaking the nuts into halves; (*c*) husking the coconuts.

in any drug store. A stock solution, that is a solution made in a large quantity and kept for use, can be prepared by dissolving 100 grams of sodium hydroxide flakes, 98 per cent commercial, in 480 cubic centimeters (cc.) of ordinary water. As a means of measuring cubic centimeters and other quantities not usually used in homes, equivalent measurements that are in all homes are given. For example a one-pound salmon can will hold 480 cc. of water, when full. In dissolving the sodium hydroxide, use jars or large bottles. Occasional stirring is necessary. As the sodium hydroxide dissolves, the water will become hot. One should be careful not to get this solution or soda lye on the hands or clothing as it will burn either one. If the solution is not clear, allow it to stand for a while and then pour it off carefully into a clean container, preferably a large bottle.

Sodium carbonate. This chemical may be bought at any drug store for about 44 centavos a kilogram. A stock solution may be prepared by dissolving 10 grams of the chemical in 100 cc. of water. A condensed-milk can (Milkmaid brand) holds 300 cc. when full. It may be used for measuring the water; if the solution is not clear, strain it through a piece of cloth, then place it in a bottle.

Wood ash lye. This lye is made by putting about five kilograms of wood ashes saved from the kitchen stove in a large jar or *pilon* with small holes in the bottom. Then pour slowly about ten liters (kerosene can half full) of water through the ashes. Place a kerosene can under the jar with the ashes to catch the liquid or lye as it

Fig. 2.—(*a*) Putting the *latek* in a wire sieve and straining the oil out; (*b*) pressing the grated coconut meat in a homemade coconut press before boiling; (*c*) a revolving coconut grater made by the Agronomy Department carpenters.

runs through. (See fig. 3a). Pour this liquid or lye through the wet wood ashes three or four times or until it feels slippery. When it feels this way when you dip your finger in it, it is strong enough for soap making. Two and one-half liters of lye can be obtained from every ten liters of water poured through five kilograms of wood ashes.

Coconut oil. The coconut oil may be extracted as follows: First, grate the coconut meat on a one-man grater or slicer as shown in figure 1a. Stationary graters may be used, but a revolving grater will be found more efficient. Such a grater can be made by any

carpenter and is easy to handle. The coconut halves are placed in such a way that when the grater revolves by working the bicycle-like pedal, the knife grates the meat fine. Put the grated coconut meat in hot water for a while and then squeeze with the hands and put it in a home-made coconut press. The manipulation of the press is shown in figure 2b. Repeat the process of pressing three or four times. Boil this coconut milk in a kettle, called in Tagalog, *cawa*, until all the water is evaporated. While it is boiling, stir it occasionally. The length of time required to evaporate the water depends upon the amount of water in the milk, so no more water than is necessary should be used in pressing. Reduce the fire as soon as the *latek* or solid part begins to form in the bottom of the

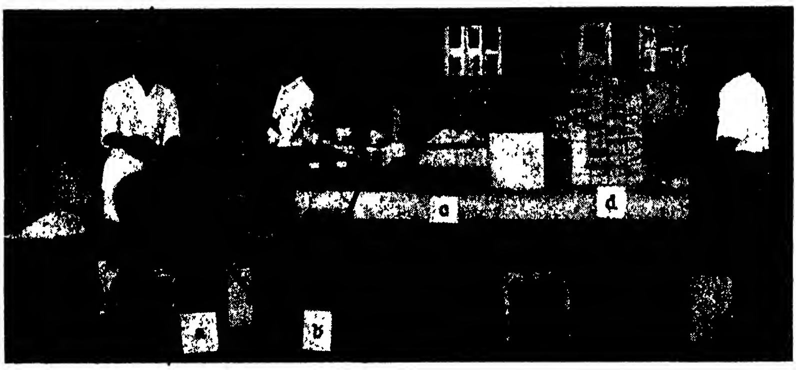

Fig. 3.—(*a*) Preparing the wood ash lye; (*b*) stove and kerosene can for boiling the soap; (*c*) a small wooden form, 30 cm. long, 30 cm. wide and 10 cm. deep for molding about seven kilograms of soap; (*d*) cutting the soap into small blocks or cakes.

kettle. Overheating at this time will produce colored oil. When the *latek* becomes dark brown in color, boiling should be stopped. The oil can be separated from the *latek* by pouring it off gently or by putting the *latek* in a wire sieve and straining the oil out. (See figure 2a). The *latek* and *sapal* (grated meat from which the milk has been extracted) can be used in the preparation of *bukayo* candy. It takes about three hours to boil one petroleum can of coconut milk. Twenty-five coconuts of Laguna type will give more than a liter of coconut oil.

Table 1 shows the amount of oil extracted from 750 coconuts in five trials. The oil was not all extracted because the *sapal* and the *latek* were made into *bukayo* candy.

TABLE 1

Showing the amount of oil extracted from a certain number of coconuts

TRIALS	COCONUTS	AMOUNT OF OIL EXTRACTED
	number	*liters*
1	50	2.52
2	100	6.44
3	150	8.77
4	200	11.44
5	250	15.16
Total	750	44.33

Wooden form to mold the soap. A box without a top in which to cool and mold the soap is necessary. (see fig. 4b.) A close view of this form while the soap is being cooled is shown in figure 5. A small form, 30 centimeters long, 30 centimeters wide and 10 centimeters deep will hold about seven kilograms of soap. (see fig. 3c.)

BOILING THE SOAP

When the materials, that is the chemicals and coconut oil, are all ready, the next step is making the soap.

Two formulas showing the proportions of the materials to be used in making soap of different amounts and kinds are here given. By "parts," as used in the formulas, is meant the number of equal constituent portions of which each formula is composed.

Formula 1

For about four kilograms of washing soap.

6 parts by volume sodium hydroxide solution
4 parts by volume wood ash lye
1 part by volume sodium carbonate solution
10 parts by volume coconut oil.

Measure and mix the first three named ingredients in a clean petroleum can. For measuring, use an empty half pint bottle; this holds 240 cc. when full.

Boil this mixture ten to fifteen minutes. While it is boiling pour gradually into it 10 parts of coconut oil. Pour with one hand and stir the liquid continuously with the other. (See fig. 4a.) The stirring is important and it should be done slowly and steadily. The oil should be poured into the lye, not the reverse, as the results will not be sat-

isfactory if the lye is poured into the oil. After all the oil has been added, reduce the fire gradually or too much foam will be formed. Avoid forming too much foam in the soap.

The boiling and stirring should continue until the lye and oil have become well mixed into a thick and smooth soap. Test it by lifting up the stirring rod to see whether the oil has been completely mixed with the lye. The soap will show a fine grain when it is properly cooked. When it is cooked take the kettle off from the fire and stir the soap very carefully. Then pour it into a clean and well made wooden form or box. The soap is now ready to cool. It should be left to harden in the form for 24 to 48 hours.

Fig. 4.—(*a*) Pouring the coconut oil into the boiling mixture with one hand and continuously stirring the liquid with the other; (*b*) wooden form to mold the soap.

Before the soap becomes too hard it should be cut into cakes with a fine string or wire, (See fig. 3d.) The size of the cakes depends on the use to which the soap is to be put and the preference of the maker.

If the soap does not have a fine enough grain, it is because the boiling mixture was not stirred properly. Should the soap not be satisfactory the cakes may be broken into small pieces and dissolved in a small amount of water, then boiled again as before. If the soap does not harden, it should be reboiled with a small amount of wood

ash lye added. When the soap is again ready, pour it into the mold and allow it to harden once more. This process can be repeated until the soap comes out satisfactory.

By using molds of different forms one can have soap cakes of different shapes.

It takes patience and experience to make good soap. The operation, however, requires far less skill than is used in cooking the daily dinner. If the first trial is not successful, do not be discouraged. Try again.

Whether it will prove profitable or not to make soap by this method will depend on the prices paid for the chemicals and other necessary materials, as well as on the efficiency in extracting coconut oil and the cost of labor used.

The following table shows the cost of materials to make about four kilograms of washing soap according to formula 1 and the value of the soap.

TABLE 2

Showing the cost of materials used for about four kilograms of washing soap and the value of soap made from five trials

SODIUM HYDROXIDE		WOOD ASH LYE		COCONUT OIL		SODIUM CARBONATE		TOTAL COST OF MATERIALS	SOAP	
Am't	Cost	Am't	Cost	Am't	Cost	Am't	Cost		Am't	Value [a]
parts	*ctv.*	*parts*	*ctv.*	*parts*	*ctv.*	*parts*	*ctv.*	*ctv.*	*kgm.*	*ctv.*
6	0.158	4	0.010	10	0.336	1	0.011	0.515	3.80	0.608
6	0.158	4	0.010	10	0.336	1	0.011	0.515	3.85	0.616
6	0.158	4	0.010	10	0.336	1	0.011	0.515	3.92	0.627
6	0.158	4	0.010	10	0.336	1	0.011	0.515	3.84	0.614
6	0.158	4	0.010	10	0.336	1	0.011	0.515	3.52	0.563

[a] Value estimated at 16 centavos a kilogram. All solutions were measured in a half-pint bottle.

Formula 2

For about 7 kilograms of cheap laundry soap.

6 parts by volume sodium hydroxide
4 parts by volume wood ash lye
1 part by volume sodium sulfate
½ part by volume ordinary salt
9 parts by volume coconut oil
1 part by volume tallow

The preparation of sodium hydroxide, wood ash lye, and coconut oil is the same as for formula 1.

Sodium sulfate. This chemical may be bought at any drug store for about 15 centavos a kilogram. A stock solution may be prepared

by dissolving 10 grams of the chemical in 100 cc. water (a condensed-milk can, Milkmaid brand, one-third full). If the solution is not clear, strain it through a piece of cloth into a clean bottle.

Tallow. This fat can be bought at almost any store for about 20 centavos a kilogram. If the tallow is dirty, clean it by melting it in a clean petroleum can over a slow fire and then straining it before it cools through a piece of *sinamay* cloth into a clean container.

Native salt. This salt can be bought for about 75 centavos a sack of 46 kilograms.

For measuring the ingredients, use a condensed-milk can (Milkmaid brand) holding 300 cc. when full. Put the first four named ingredients in a clean petroleum can or *cawa* and mix them well.

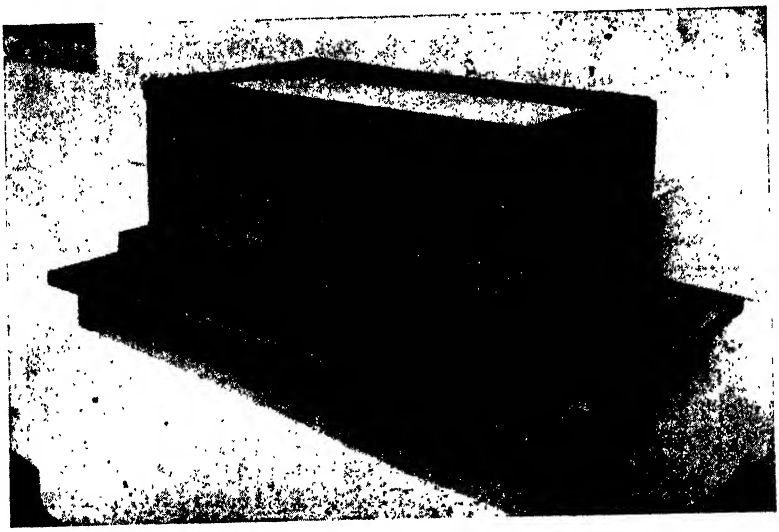

Fig. 5.—Wooden form for cooling and molding the soap.

Boil the mixture for fifteen or twenty minutes and then pour gradually into the boiling solution 9 parts of coconut oil, stirring the liquid continuously. (See figure 4a.) The fire should be reduced so as not to produce too much foam in the soap. About one minute after all the oil has been added, take 1 part clean cooled tallow measured in a 300 cc. condensed-milk can (Milkmaid brand) and add it little by little. If the mixture boils too much after the oil and tallow have been added, take it off from the fire and stir it very well. Then boil it again. The boiling and stirring should continue until the lye, oil and tallow have become well mixed into a thick and smooth soap. Before pouring the soap into the form, cool it for a while, stirring all the time.

When the soap is ready, pour it at once into a clean and well made wooden form and cool it for 24 hours or more.

Table 3 shows the cost of the different materials used for about seven kilograms of cheap laundry soap and the value of the soap made in five trials according to formula 2.

TABLE 3

Showing the total cost of materials used for about seven kilograms of washing soap and the value of the soap made in five trials

SODIUM HYDROXIDE		WOOD ASH LYE		COCONUT OIL		SODIUM SULFATE		TALLOW		ORDINARY TABLE SALT		TOTAL COST OF MATERIALS	SOAP	
Am't	Cost	Am't	Cost	Am't	Cost	Am't	Cost	Am't	Cost	Am't	Cost		Am't	Value[a]
parts	*ctv.*	*parts*	*ctv.*	*parts*	*ctv.*	*parts*	*ctv.*	*parts*	*ctv.*	*parts*	*ctv.*	*ctv.*	*kgm.*	*pesos*
6	0.198	4	0.012	9	0.378	1	0.005	1	0.050	½	0.003	0.646	6.85	1.096
6	0.198	4	0.012	9	0.378	1	0.005	1	0.050	½	0.003	0.646	6.72	1.075
6	0.198	4	0.012	9	0.378	1	0.005	1	0.050	½	0.003	0.646	6.92	1.107
6	0.198	4	0.012	9	0.378	1	0.005	1	0.050	½	0.003	0.646	6.84	1.094
6	0.198	4	0.012	9	0.378	1	0.005	1	0.050	½	0.003	0.646	6.86	1.097

[a] Value estimated at 16 centavos a kilogram. All solutions were measured in condensed-milk can holding 300 cc. when full.

Observations on loss of weight. Thirteen cakes of soap, 10 cm. long, 5 cm. wide, and 4 cm. thick were weighed after cutting. The loss in weight was taken and the results are given in table 4.

TABLE 4

Showing the loss in weight in storage

DATE	WT. WHEN CUT	LOSS IN WT.	DAYS
1933	*grams*	*grams*	
January 19	2703	—	—
February 6	2610	93	18
February 21	2515	188	33
March 20	2330	373	60
April 20	1993	710	91
September 5	1690	1013	228

After 228 days in storage, more than 37 per cent of the original weight had been lost in drying. The cakes, however, became very much harder than they were after cutting. Well-dried soap is to be preferred as it does not dissolve so easily when used.

TESTIMONIALS

Some people who have bought and used the soap prepared in the Agronomy Department according to the formulas given in this circular have written us their opinion of the product:

"The soap which you gave me has proved satisfactory. I keep a piece near the sink in the laboratory." (Sgd.) D. I. AQUINO
Instructor in Soil Technology

"I made fine soap on a commercial scale. I concluded that by the formulas for soap making in the Agronomy Department, College of Agriculture if properly followed, one can make soap for his own use instead of buying the foreign make." (Sgd.) JUAN C. VILLANUEVA
Business man

"The soap is a little too soft. It is very good otherwise."

(Sgd.) F. B. SARAO
Instructor in Animal Husbandry

"Your soap is all right but what I observed in using it is that it consists of two layers—one layer exhausts easily, showing that it contains merely foam." (Sgd.) MAMERTA MANAHAN-ILAGAN
Assistant in Agricultural Chemistry

"The soap that I bought from the Agronomy Department is good for cleaning clothes." (Sgd.) TIBORCIO MEDIALDIA
Agronomy Laborer

"Your soap is a little hard on the hands, but good for clothes."

(Sgd.) EUSEBIO MALABAYABAS
Mechanic

"Your soap is good for it cleans easily. Is cheap and hard."

(Sgd.) A. FRIAS
Carpenter

"Good for cleaning empty milk bottles that we are using in the Animal Husbandry Department. Good also for clothes, hands, plates and other things where soap is needed in cleaning."

(Sgd.) ANDRES HORMIGUERA
Laborer

"The coffee, chocolate and soap that you gave me for trial were quite up to commercial standards. I should imagine that if your products could be extended, there will be no trouble in finding market for them." (Sgd.) ALEXANDER GORDON
Care of Central Azucarera de la Carlota

"The soap which you are making is an excellent laundry soap. It makes the clothes clean and white. I am glad to endorse it for you. It is also much cheaper than laundry soaps on the market."

(Sgd.) NONA S. BOUSMAN
Care of United Evangelical Church

BUNCHY-TOP OF ABACÁ, OR MANILA HEMP: II. FURTHER STUDIES ON THE TRANSMISSION OF THE DISEASE AND A TRIAL PLANTING OF ABACÁ SEEDLINGS IN A BUNCHY-TOP DEVASTATED FIELD [1]

G. O. OCFEMIA AND GABINO G. BUHAY
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WITH TWO TEXT FIGURES

In an earlier paper by the senior author (Ocfemia, 1930, p. 2 and 11) statements were made that the results of experiments to determine (1) the transmissibility of the bunchy-top of abacá (*Musa textilis* Née) to the important varieties of banana in the Philippines and (2) the shortest time required by virus-free *Pentalonia nigronervosa* Coq. to obtain the infective material from diseased abacá and transmit it to healthy plants, would be reported in the second paper of this series. The work on which this, the second paper, is based was completed in March, 1932.

From April, 1925 up to the present time the senior author has not seen bunchy-top on Philippine varieties of banana and plantain even when growing side by side with abacá seriously infected with the disease. This is surprising because the insect vector of bunchy-top, *Pentalonia nigronervosa* may be in great abundance on abacá, banana and plantain.[2] This observation is of great interest because in Australia, bunchy-top is one of the most important diseases of the banana and it is reported that this disease has been transmitted to abacá (Anon. 1925, 1926). Gadd (1925) also reported that abacá was infected by the bunchy-top from plantain in the Peradeniya Experiment Station in Ceylon.

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[1] Portions of the data in this paper were used in a thesis presented by the junior author for graduation, 1932, from the College of Agriculture, with the degree of Bachelor of Science in Agriculture No. 371; Experiment Station contribution No. 922.

Received for publication September 1, 1933.

[2] On August 18, 1933, Dr. L. B. Uichanco of the Department of Entomology called the senior author's attention to the presence, in great abundance, of *Pentalonia nigronervosa* on camia, *Hedychium coronarium* Koenig (Zingiberaceae), a plant grown around homes for the exquisite odor of its delicate white flowers.

FAILURE OF TRANSMISSION OF THE BUNCHY-TOP OF ABACÁ TO IMPORTANT PHILIPPINE VARIETIES OF BANANA

Experiment 1. On April 10, 1928 the roots, leaves and outer older leaf sheaths of two suckers of Latundan banana, *Musa sapientum* L. var. *cinerea* (Blanco) Teodoro were removed and the suckers were washed in running water. The outer older leaf sheaths were removed so as to expose the inner and more tender tissues of the pseudo-stem. Wingless adult aphids were transferred from diseased abacá to the banana suckers, following the method described by Ocfemia (1930). One of the suckers received 40 adult virus-bearing *Pentalonia nigronervosa* and the other, 50 adult virus-bearing insects. After transferring the aphids the suckers were placed in a large battery jar which had water in the bottom, about five centimeters deep, to keep the plants fresh. The mouth of the jar was covered with cheese cloth to prevent entrance of enemies of the aphids. After allowing the aphids to feed on the banana stems for 48 hours the insects were removed and the suckers were planted in 24-centimeter pots containing sterilized soil. The pots were placed on a bench out of doors for development and observation. The result of this experiment was negative; the banana suckers grew luxuriantly but they did not show symptoms of bunchy-top.

Experiment 2. On May 7, 1928 two suckers of Buñgulan banana, *Musa sapientum* L. var. *suaveolens* (Blanco) Teodoro and two of Lacatan, *Musa sapientum* L. var. *lacatan* (Blanco) Teodoro were treated as in experiment 1 and were heavily infested with wingless adult aphids which were taken from diseased abacá. The aphids were allowed to feed for 48 hours and the insects were destroyed before the banana suckers were planted in 24-centimeter pots, using sterilized soil. On June 30, 1928 the potted suckers were reinfested with an abundance of wingless adult and virus-bearing *Pentalonia nigronervosa.* This time the aphids were allowed to feed on the banana suckers for 18 days before they were destroyed by spraying with 1:1500 Black Leaf "40"-soap solution. Up to August 3, 1928, however, the banana suckers had not shown symptoms of bunchy-top. After August 3 the plants were discarded and destroyed.

Experiment 3. In June, 1931 ten healthy suckers of each of Latundan, *Musa sapientum* var. *cinerea,* of Buñgulan, *Musa sapientum* var. *suaveolens,* of Saba, *Musa sapientum* var. *compressa* (Blanco) Teodoro of Lacatan, *Musa sapientum* var. *lacatan,* and of Chinese dwarf banana, *Musa cavendishii* Lamb., all of which were 10 to 12 centimeters in diameter at the base of the pseudostem, were secured.

The suckers were cleaned as were those used in experiment 1 and immediately planted in 24-centimeter pots containing sterilized soil. Ten other suckers of each of these five varieties of bananas, which were growing under field conditions behind the laboratory were cleaned and the pseudo-stems cut off in order to allow new growths to appear.

On August 2, 1931, when the banana plants in the pots and those growing out of doors had from two to three leaves, the outer old leaf sheaths of the plants were removed so as to expose the inner more tender tissues of the pseudo-stems.

Fifty adult wingless aphids which had been allowed to feed on diseased abacá plants for five days were transferred to each of the bananas, in the pots and in the field. The banana suckers in the field with the aphids on them were covered with cheese cloth. The potted banana plants were left in the laboratory without cover. After allowing the virus-bearing aphids to feed for ten days they were atomized with 1:1500 Black Leaf "40"-soap solution. The covers of those in the field were removed and the potted plants were placed on a bench outside the laboratory. Observations for the development of bunchy-top were made at regular inspections.

No symptoms of bunchy-top were produced on the different varieties of bananas used in this experiment. The bananas on which virus-bearing aphids were allowed to feed and multiply in great abundance grew as normally as did the control plants.

As the banana suckers on which virus-bearing aphids were allowed to feed did not exhibit bunchy-top symptoms, an experiment was conducted to determine whether healthy *Pentalonia nigronervosa* could recover the infective principle from the experimental banana suckers. This experiment was tried because in 1928 the senior author noted that if virus-free aphids were allowed to feed on the bananas that had been used in transmission experiments but had not become infected, the insects could not produce bunchy-top on abacá seedlings.

Forty days after killing the virus-bearing aphids on the bananas with Black Leaf "40"-soap solution an abundance of wingless adult insects taken from healthy abacá plants were transferred to the banana suckers. After allowing the aphids to feed on these bananas for 10 days they were again transferred to healthy abacá seedlings that were about twenty centimeters tall. Four healthy abacá seedlings were used for the aphids taken from each of the different varieties of bananas. The result of this experiment was

negative; that is none of the abacá plants used developed bunchy-top. Although the writers do not consider the results of a single experiment as conclusive proof, evidence thus far seems to show that the different varieties of banana used did not have the virus in them.

Following the definitions given by Stahl and Faris (1929, p. 12) in regard to reactions of sugar cane varieties to mosaic, the Philippine varieties of banana and plantain and including *Musa cavendishii* may be considered immune to the bunchy-top of abacá occurring in this country. These bananas and plantains have the ability to ward off infection of the disease completely as shown by the absence of the disease in the field and by the failure to infect them under controlled conditions in the laboratory.

The absence of bunchy-top in Philippine varieties of banana in nature and the failure to transmit the disease from abacá to banana and plantain under controlled conditions corroborate the earlier report of Ocfemia (1930). Unless it is assumed, however, that the virus causing bunchy-top of abacá in the Philippines is not the same as that causing bunchy-top of banana in Australia it is difficult to explain why *Musa cavendishii,* the most susceptible commercial variety of banana in Australia, can not be infected with the Philippine abacá bunchy-top at Los Baños. Professor S. F. Ashby, Mycologist, Imperial Mycological Institute at Kew, England, in a letter to the senior author suggests that possibly the cause of the bunchy-top of banana in Australia (Anon. 1925, 1926 and Magee, 1927) may be considered as virus No. 1; the cause of Magee's (1930) new virus disease of bananas as virus No 2; and the cause of the abacá bunchy-top in the Philippines as virus No. 3. Professor Ashby's suggestion is based on the senior author's earlier reports (1927, 1930) that the (1) final stage of 11 to 17 per cent of the abacá infected with bunchy-top in the field is a heart rot and (2) the disease does not infect Philippine banana and plantain in nature. To determine whether or not the virus of abacá bunchy-top in the Philippines is different from that causing bunchy-top of banana in Australia would require the introduction of healthy as well as infected *Musa cavendishii* from that region. The healthy *Musa cavendishii* may be used in transmission experiment with the virus in Philippine bunchy-top of abacá and the infected banana may be used as source of virus for transmission to Philippine banana and plantain. The imminent danger of introducing potential diseases and pests attendant with such introductions, however, seems too serious to warrant this attempt to settle this interesting question.

THE SHORTEST TIME REQUIRED BY PENTALONIA NIGRONERVOSA COQ. TO OBTAIN THE BUNCHY-TOP VIRUS FROM DISEASED ABACÁ PLANTS AND TRANSMIT IT TO HEALTHY ABACÁ SEEDLINGS

Ocfemia (1930, p. 10, 11) reports failure of transmission of abacá bunchy-top when 20 young or 20 adult aphids were allowed to feed for 24 hours on diseased abacá seedlings and then transferred to healthy abacá plants and allowed to feed on these for 48 hours. The same result was obtained when 20 young or 20 adult aphids were allowed to feed on diseased abacá seedlings for 48 hours and then transferred to healthy abacá seedlings and allowed to feed on these for 48 hours. Ocfemia (1930) further reports that the shortest time of feeding on diseased plants by the aphids in order to obtain the virus was 100 hours. In addition to this time the virus-bearing insects required about 48 hours of feeding on healthy plants before they could transmit the disease.

Two experiments were conducted in 1931 to determine the shortest time required by *Pentalonia nigronervosa* to obtain the virus from diseased abacá and transmit it to healthy plants. For these experiments fresh seeds from healthy abacá plants were secured in April, 1931. The seeds were germinated and the seedlings grown according to the method described in the first paper of this series (Ocfemia, 1930).

When the seedlings were about 30 centimeters high about 3,700 wingless adult *Pentalonia nigronervosa* were transferred to several healthy potted abacá plants and allowed to multiply. When the aphids were very numerous the wingless adults were transferred to bunchy-topped abacá plants.

Experiment 1. The adult aphids were allowed to feed on diseased abacá plants for different lengths of time. The lengths of feeding tried in two experiments were 3, 6, 12, 24, 48, 60 and 72 hours. After the aphids had been allowed to feed for the desired length of time, twenty-five of the wingless adult insects were transferred to each of eight healthy potted abacá seedlings. Two potted plants without aphids were used as checks for each length of feeding. The abacá plants with insects on them and the checks were covered with cheese cloth. The virus-bearing aphids were allowed to feed on the healthy plants for 24 hours in one set of four plants each and 48 hours in another set also of four plants each. Each set had a series of controls. After feeding on the healthy plants for these two periods of time the aphids were killed by atomizing them with a solution containing 1 cc. of Black Leaf "40", 5 grams of laundry soap and 1500 cc. of tap water.

In experiment 1, twenty-five wingless adult *Pentalonia nigronervosa* were allowed to feed for twelve hours on bunchy-topped abacá, then were transferred to healthy abacá seedlings where they were allowed to feed for 48 hours. These abacá plants showed reliable symptoms of bunchy-top after 48 days.

Experiment 2. In experiment 2, twenty-five aphids were allowed to feed for twelve hours on bunchy-topped abacá, then they were transferred to healthy abacá seedlings on which they were allowed to feed for 48 hours. These plants exhibited symptoms of the disease after 56 days.

In both of these experiments it was noted that increasing the number of hours of feeding on diseased plants to obtain the virus did not reduce the number of hours of feeding on the healthy plants from 48 to 24 hours in order to cause transmission. The incubation period of the disease, however, was reduced from 48 to 50 days to 29 to 32 days by allowing the insects to feed from 12 hours to 72 hours on diseased plants.

The results of these experiments seem to show that the infective principle, or virus of abacá bunchy-top requires an incubation period of 24 to 48 hours in the body of the insect vector before it can cause infection. In this respect, abacá bunchy-top is caused by a virus of the same type as that which causes the curly top of beets in the United States. In curly top of beets, Smith and Boncquet (1915) found that the infective principle requires an incubation period of 24 hours in the body of the insect vector before it is capable of causing the disease on the beets.

In regard to the incubation period of the bunchy-top, the writers found that the longer the virus-free aphids feed on diseased abacá plants (60 and 72 hours), the shorter is the time which elapses between inoculation and appearance of the first visible symptoms (30 and 32 days). As stated in an earlier paper (Ocfemia, 1930), the faster the plants grew the earlier the symptoms of bunchy-top appeared.

In conclusion it may be stated that the shortest time required by adult *Pentalonia nigronervosa* to obtain the infective principle was 12 hours; that is, twenty-five aphids required 12 hours of feeding on diseased abacá to obtain the virus. In addition to this time, between 24 and 48 hours must elapse before the insects are capable of causing infection on healthy seedlings.

NON-TRANSMISSIBILITY OF THE ABACÁ BUNCHY-TOP VIRUS TO THE OFFSPRING OF THE APHIDS

From 1925 to 1927 the senior author found in his experiments at the College of Agriculture that the infectious material in the virus-carrying *Pentalonia nigronervosa* was not transmitted to the young which were born of the adult aphids. Further experiments conducted in 1928 and 1931 confirmed the earlier conclusion.

Experiment 1. On April 10, 1928 more than 40 adult virus-bearing *Pentalonia nigronervosa* were transferred from infected abacá to the tender stalks of healthy Latundan banana which were kept in a battery jar with a small amount of water in the bottom and covered with cheese cloth over the top. After 22 hours the young aphids which were born of the adult insects were transferred to two three-month-and 19-day old potted (Ilayas ♀ × Itom ♂) F_1 abacá seedlings. Ten insects were placed on one plant and five on the other. Both of these seedlings remained healthy for several months showing that the young aphids which were placed on them did not carry the bunchy-top virus which their parents possessed. The failure to cause infection of the young abacá plants could not be attributed to the smaller number of aphids used because in 1930 it was reported that five aphids were sufficient to transmit the disease.

Experiment 2. On April 12, 1928 the second crop of young aphids on the Latundan banana consisting of ten individuals was transferred to one potted abacá seedling, variety (Ilayas ♀ × Itom ♂) F_1 which was three months and 21 days old. This plant also remained healthy for several months.

Experiment 3. On April 13 and 14, 1928 another experiment was carried out following the method employed in experiments 1 and 2. The same variety of abacá seedlings used in experiments 1 and 2 were used. Up to July 5, 1928, however, none of the young abacá plants on which the young aphids from virus-bearing parents were allowed to feed and grow showed symptoms of bunchy-top.

Experiment 4. An abundance of adult wingless aphids which were allowed to feed on bunchy-topped abacá for five days were transferred to six Petri dishes which were lined with filter paper that was moistened with dilute bee's honey. This method was suggested by Dr. L. B. Uichanco, Professor of Entomology at the College of Agriculture at Los Baños to whom the writers are much indebted for suggestions. The aphids in the Petri dishes were closely watched for the production of young. The young born were at once trans-

ferred from the Petri dishes to 17 healthy Lausigon abacá seedlings which were about one and a half months old, at the rate of 25 aphids per plant.

After placing the young aphids on the healthy abacá seedlings they were covered with cheese cloth to protect them from their enemies.

The young aphids were allowed to feed for one month. During this time they became adults and multiplied in great numbers. Careful examination for the appearance of bunchy-top symptoms was made from January 12, 1932 to February 26, 1932 but none of the abacá plants became diseased. The result showed that the young insects which were born of virus-bearing parents did not receive the infective principle from their parents.

The results of these experiments confirm an earlier report (Ocfemia, 1930, 1931) that the virus of bunchy-top of abacá is not transmitted to the offspring of virus-bearing *Pentalonia nigronervosa.*

FAILURE OF TRANSMISSION OF BUNCHY-TOP VIRUS BY PIN PRICKS

The failure of transmission of abacá bunchy-top by injecting the sap of diseased plants into healthy plants with a hypodermic syringe and with a knife which had been used for chopping diseased abacá was reported in an earlier paper (Ocfemia, 1930, p. 12, 13). Inoculations in 1928 following a method similar to that described by Matz (1933) for communicating sugar cane mosaic also gave negative results.

Following the method described by Wilbrink (1929), and Sein (1930) for inoculating sugar cane mosaic, several black No. 0 Asta insect pins were used in experiments on transmission of bunchy-top by pin pricks. Twenty of these pins were tied together on the end of a stick in such a way that they formed a stiff and sharp-pointed brush. The plants to be inoculated were cleaned by removing the outer leaf sheath so as to expose the more tender tissues of the pseudo-stems. Inoculation was performed by taking a fresh leaf sheath or young leaf of bunchy-topped abacá and holding it tightly with the thumb and the index finger of the left hand against the stalk of the healthy abacá plant which was to be inoculated. The brush of pins was thrust rapidly through different parts of the diseased portion deep enough to reach the healthy stalk. Pricking was repeated several times in rapid succession around the healthy abacá plants. Seventeen healthy potted abacá seedlings which were

about twenty centimeters high were used in the experiment. The inoculated plants were placed in a trough of water on a bench outside of the laboratory. Observations were made daily from January 4, 1932, to February 27, 1932 for the appearance of bunchy-top, but none was seen.

The result of this experiment corroborates Ocfemia's (1930) report that the virus causing bunchy-top is not transmissible by mechanical means. According to this result abacá bunchy-top belongs to a group of virus diseases the transmissibility of which is restricted to the activity of an insect vector. This characteristic of the bunchy-top of abacá is of importance in the control of this disease. Its virus can not be transmitted by knife cuts or by implements used in cultural operations as can the viruses of the tobacco (*Nicotiana tabacum* L.) and cucumber (*Cucumis sativus* L.) mosaics. With this knowledge, all efforts to prevent infection or transmission and dissemination of the disease in rehabilitation of abacá fields entirely devastated by bunchy-top can be centered upon (1) *Pentalonia nigronervosa,* the vector and (2) diseased abacá plants, the source of inoculum.

A TRIAL PLANTING OF ABACÁ SEEDLINGS ON A BUNCHY-TOP DEVASTATED FIELD

The results of experiments in pots and small plots performed since 1925 showed that bunchy-top infected abacá plants may be replaced successfully (Ocfemia, 1930, 1931a, b). The occasional occurrence of the disease in replaced plants is due to our inability to detect the presence of aphids that come from diseased plants. With this conclusion the senior author believes that diseased plants in the field may also be replaced successfully if proper precautions are taken. For this reason a trial planting of abacá seedlings in a bunchy-top devastated field was started in 1928.

Preparation of the land

A piece of land, about one hectare in size, was selected by the junior author in May, 1928 in the southeastern part of the barrio of Kay-Kiwit, Indang, Cavite Province. The land was at one time a flourishing abacá field but the abacá on it was completely wiped out by bunchy-top and the heart rot that follows in 11 to 17 per cent of bunchy-top infected plants. The first step was to clear the land and remove all abacá and banana stools on it. The corms and roots of

abacá and banana were completely removed and the whole field was rested for about two months. Ocfemia (1931a, b) recommends resting the land from nine to twelve months. The purpose of this resting is to provide a condition in which all virus-bearing *Pentalonia nigronervosa* will die. The eradication of the virus bearing aphids is less difficult owing to the fact that in our experiments the virus in the parent is not transmitted to the offspring.

Production, care and handling of the abacá seedlings

While the land was being rested, seeds of the different varieties of abacá were secured by the senior author. Some of the seeds came from Mr. Domingo Baybay, Superintendent of the Guinobatan Abacá Experiment Station of the Bureau of Plant Industry, situated at Binogsacan, Guinobatan, Albay. Other seeds came from Indang, Cavite and still others from the College of Agriculture at Los Baños. The seeds were germinated in the experimental plot of the Department of Plant Pathology and the seedlings were raised at Los Baños. Great care was taken to prevent aphid infestation by constant and regular inspection of the plants and spraying them at frequent intervals with Black Leaf "40"-soap solution.

Planting the seedlings in Indang, Cavite

When the seedlings were about four months old, they were pulled up from the plots and the roots pruned to a few centimeters. The corms were washed and the greater part of the leaves were removed. The seedlings were transported to Cavite where they were planted in the one hectare of land previously prepared. The young plants were set at four by four meters apart. The holes and the soil around them were sprayed with 1:1500 Black Leaf "40"-soap solution.

After planting, the abacá plants were sprayed with the aphicide in order to be sure that all aphids were killed.

The field was visited at four to five weeks intervals. In addition to these visits, the plants were cared for by hired labor. The seedlings of the different varieties of abacá were planted as they became available. Because abacá requires plenty of water to start its growth, most of the plantings were made at the beginning of the rainy season. Table 1 shows the varieties of abacá planted, the number of seedlings used, and date they were set in the field, the plants that died and those living at date of final inspection.

TABLE 1

The abacá plantings made in Indang, Cavite Province from September 22, 1928 to June 3 to 6, 1930 and their condition when the final inspection was made on October 31, 1932

DATE OF PLANTING	NUMBER OF SEEDLINGS USED	VARIETY NAMES OF ABACÁ PLANTED [a]	NUMBER OF PLANTS THAT DIED			NUMBER OF PLANTS LIVING AT DATE OF FINAL INSPECTION
			From drought	From poor soil condition [b]	From bunchy-top	
1928						
September 22	238	(C. A. 10302 Itom ♀ × C. A. 4279 Sinamoro Puti ♂) F_1	180	42	0	16
October 18-22	223	(C. A. 10302 Itom ♀ × Unknown ♂) F_1	193	15	0	15
December 20	198	(C. A. 10302 Itom ♀ × Itom ♂) F_1	160	31	0	7
1929						
July 7	42	(C. A. 10302 Itom ♀ × Itom ♂) F_1	4	0	0	38
1930						
June 3-6	66	(C. A. 10302 Itom ♀ × C. A. 4279 Sinamoro Puti ♂) F_1	0	0	0	66
	47	(Itom ♀ × Unknown ♂) F_1	8	0	0	39
	4	Indang variety	0	0	0	4
	87	Unknown variety from Indang	0	0	2	85
Total	905		545	88	2	270

[a] The variety hybrids were part of the abacá plants used by G. O. Ocfemia in his work which was reported in the first paper of this series in 1930.

[b] Stony and with very thin layer of soil.

Care of the field after planting

As the work on the trial planting in Indang progressed the young abacá field was cleaned every month. Sometimes the whole field was cleaned, but usually only ring cleaning was done. In cleaning, the dry leaves and leaf sheaths were removed and the hills cultivated around the plants. Table 1 shows the data on results when the final inspection was made on October 31, 1931 of the plantings made of young abacá seedlings in Indang, Cavite from September 22, 1928 to June 3 to 6, 1930.

Results

Observations made on the one-hectare planting during the progress of the work showed that there were fewer deaths after the

Fig. 1.—A view of two rows of (C. A. 10302 Itom ♀ × C. A. 4279 Sinamoro Puti ♂) F_1 variety of abacá planted at Indang, Cavite. Photographed by Enrique Escalante when the abacá plants were eleven months old. These plants were grown from seeds. Note that the plants are vigorous and free from bunchy-top.

plants had established themselves in the soil and when they were frequently cultivated. Of the total of 905 abacá seedlings grown from seeds of the different varieties raised at Los Baños and suckers taken from Indang, only 270 plants, or 29.83 per cent remained alive in the field of one hectare. The plants that survived in the different portions of the field, however, were entirely free from bunchy-top. Only two of the plants from suckers that were obtained from old abacá corms from Indang were infected with bunchy-top. In none of the regular monthly visits to the field during the period of about

three and half years was any case of bunchy-top noted among the plants from the seedlings raised at Los Baños.

The chief cause of death of the seedlings was the drought that followed the rainy season during which the seedlings were set in the field. Of the total number of seedlings planted 545, or 60.22 per cent died during the dry weather. The seedlings suffered much from the dry weather because they were transported to Indang when they were about four months old and after the greater part of the leaves and the roots were removed. The young plants were very greatly set back by the pruning of the leaves and roots and they were just started on the new roots produced in Indang when the dry season came again. After the plants were set in the field the rainy

Fig. 2.—A view of two stools of (C. A. 10302 Itom ♀ × C. A. 4279 Sinamoro Puti ♂) F_1 at Indang, Cavite. Photographed by Enrique Escalante when abacá plants were three years and one month old. Note the absence of bunchy-top and the relative abundance of suckers of each hill.

season was not sufficiently long to allow the seedlings to establish their root systems in the soil. It was not possible to irrigate the young plantings in Indang. Experience at Los Baños shows that young abacá plants thrive best when their roots are in very wet or even saturated soil.

A much greater percentage of the plants would have withstood the transportation to Indang and the climate of the locality had they been transported with all of their roots undisturbed in the soil where they were grown or had it been possible to irrigate the plants in the field in the dry season as can be done in Los Baños. The stand of the

first plantings of the variety hybrid (C.A. 10302 Itom ♀ × C.A. 4279 Sinamoro Puti ♂) F_1 when they were eleven months old is shown in figure 1 and when the plants were three years and one month is shown in figure 2. In spite of the low percentage of healthy plants surviving from drought and other causes the writers and the abacá growers who were requested to pass judgment on the replantings are of the opinion that it is quite possible to rehabilitate the abacá industry in bunchy-top devastated fields. If suckers from disease-free regions are not obtainable, plants grown from seeds should be used. The plants should be raised near the field to eliminate the transporting of the seedlings from a distance, and the necessity of pruning the roots and leaves. Seedlings should be set when they are sufficiently old to withstand rough handling. Planting of very young seedlings should be done only when there is an abundance of irrigation water so that the plants will not suffer during the dry season.

SUMMARY

1. The bunchy-top of abacá in the Philippines does not occur on bananas in nature and can not be transmitted to them by *Pentalonia nigronervosa* Coq.

2. In the present study it was found that twelve hours is the shortest time required by *Pentalonia nigronervosa* to obtain the bunchy-top virus from diseased abacá plants and transmit it to healthy abacá seedlings. The virus can cause infection after undergoing an incubation period of from twenty-four to forty-eight hours in the body of the insect. The incubation period of the disease in fast growing seedlings is shorter (30 to 32 days) than in slow growing abacá seedlings (60 to 72 days).

3. The virus causing bunchy-top of abacá is not transmitted to the progeny of virus-bearing aphids.

4. Bunchy-top of abacá can not be transmitted to healthy abacá plants by pin-prick method as the mosaic diseases can.

5. An abacá field completely devastated by bunchy-top may be rehabilitated. In the rehabilitation work, the most important cause of loss of seedlings is drought. The loss of seedlings may be reduced by planting larger plants grown in the neighborhood where the field planting is to be done. An abundance of water is essential for the plantings during the dry season that follows the rainy months. If suckers are used they must be obtained from places where the disease is known not to occur.

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PROTEIN SUPPLEMENTS IN POULTRY RATIONS: I. COMPARATIVE STUDIES OF THE EFFECTS OF SHRIMP MEAL, MEAT SCRAPS, TANKAGE AND FISH MEAL AS SUPPLEMENTS IN RATIONS FOR GROWING CHICKENS [1]

F. M. FRONDA, ACELO C. BADELLES AND JUAN S. PADILLA

WITH TWO CHARTS

For poultry feeding, there are two common sources of protein concentrates, plants and animals. Much has been written about animal proteins being superior to vegetable proteins. Probably one of the reasons for this is that animal products, are as a class of feed, much richer in proteins than plant products. It has been generally assumed, also, that the better results obtained with animal products were due to the nature of the proteins that they contain.

It is also a common experience among poultry raisers that protein supplements are the most expensive part of the ration both for laying hens and for growing chickens. As a consequence, a poultry raiser faces the problem of securing protein feeds in large quantities and at prices that will enable him to feed his chickens properly for normal growth and egg production. Therefore, studies along this line are essential.

The present paper is a report of studies to determine the comparative effects upon the growth of chickens of various animal protein feeds that may be available in the Islands. The experiments were conducted in the Poultry Division, Department of Animal Husbandry, College of Agriculture from July, 1931 to May, 1932.

REVIEW OF LITERATURE ON THE SUBJECT

Fronda (1929) made a study of the effects of shrimp meal and fish meal as supplements in the ration for egg production and

[1] The greater part of the data in this paper was in a thesis presented jointly by the junior authors for graduation, March, 1932, with the degrees of Bachelor of Science in Agriculture and Bachelor of Agriculture from the College of Agriculture, No. 372; Experiment Station contribution No. 923. The thesis was prepared under the direction of Dr. F. M. Fronda, Assistant Professor of Poultry Husbandry.

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found that both meals produced satisfactory results when they constituted 5 per cent of the laying ration. When they formed 10 per cent of the laying ration they stimulated egg production, but under these conditions it was not profitable. Fronda found further that the check lot, receiving no supplement, had the highest mortality and the birds made the smallest gain in weight.

Titus, McNally and Hilberg (1930) in a feeding experiment with growing chicks in which the diets contained 10 per cent of the protein supplements observed that meat meal was the most efficient; the diets containing the two kinds of fish meal tested were about equal in efficiency; the diet containing the shrimp "bran" was the least efficient. The shrimp "bran" in this case was manufactured for animal feeding from the non-edible waste of the shrimp industry and consisted principally of the heads of shrimps and the whole bodies of the rejected ones.

Serrano (1928) conclusively indicated the superior effects of shrimp meal compared with copra meal as supplement in a ration for laying hens. Santiago (1926) found that shrimp meal can be profitably used as supplement in a ration for growing hogs.

Halpin, Johnson and Hart (1927) found that when meat scraps were substituted for milk in the ration of chicks, 30 per cent mortality was encountered and the chicks at 16 weeks old weighed 30 per cent less than the chicks fed with liquid milk. They found also that when meat scraps were used the chicks were unthrifty in appearance and thin in flesh. Studies at the Indiana Station showed that the addition of tankage in varying amounts to the ration of chicks was unsatisfactory, for not only was the ration unpalatable but the rate of growth was slow and the mortality was high. (Anonymous, 1927)

Sherwood (1924) experimenting on the comparative influence on laying hens of various protein feeds, found that the ration containing tankage was as palatable as the ration containing meat scraps, and the egg production of the tankage lot was as good as that of the meat scraps lot. With swine, Ashbrook (1917) reported that both tankage and fish meal produced exceptionally high daily gains and at the same time maintained thrifty growth. Scot (1926) found that pigs on a ration with fish meal made a better daily gain than the pigs on a ration with meat meal.

McFarlane, Graham, and Hall (1931) in their studies on protein nutrition of chicks reported that little or no growth was made by the chicks fed with meat meal and tankage. The chicks formed

the habit of cannibalism and toe and feather picking. In general, the post mortem conditions were similar in both lots but the eroded and exfoliated condition of the lining membrane of the gizzard was more serious and more prevalent in the tankage lot. In some cases the lining membrane of the gizzard was practically destroyed; in others it was darkened, shrunken and appeared as if slightly burned, suggesting, according to these investigators, that something toxic was present in meat meal and particularly so in tankage. The chicks in the fish meal lot were in their best condition during the first two weeks of their lives; later, they manifested a general dullness and the mortality was high. All of the chicks were very anemic.

Lee (1921) in his experiment on feeding laying hens found that the production of eggs in the lot fed with a ration supplemented with fish scraps was slightly better than in the meat scraps lot. In a test conducted with tankage he found that this protein gave as good egg production as meat scraps. Kaupp (1925), on the other hand, found that fish meal and meat meal were practically equal, pound for pound, on a protein basis as source of protein for egg production. He further found that meat meal, condensed buttermilk, dried buttermilk and fish meal have practically the same value for young chicks, when fed on the basis of their protein content.

Byerly, Titus and Ellis (1933) reported that fish meal compared favorably with meat meal and buttermilk when used as supplement in rations for egg production. When used as supplement in rations for chicks, Asmundson and Biely (1932) observed that there was no significant difference in the average weights of chicks at eight weeks when fed rations supplemented with fish meal or skim milk to supply 10 per cent of protein.

PLAN OF THE EXPERIMENT

Materials and methods. Los Baños Cantonese chicks were used in this study. All of these chicks were artificially hatched and brooded artificially in home-made fireless brooders. There were four series of tests made in this study. In the first series started on July 9, 264 chicks were used; in the second, started July 19, 228 chicks; in the third, started on July 31, 100 chicks; and in the special series for fish meal, started on October 11, 80 chicks.

The chicks in each series or set, with the exception of the fourth, were carefully divided into four equal lots. In the special series, the fourth set, for fish meal only, there were two lots of 40 chicks each.

Each lot was designated according to the supplements given to the lot, as lot 1, shrimp meal; lot 2, meat scraps; lot 3, tankage; lot 4, fish meal; and lot 5, no protein supplement.

Rations used. The ration used consisted of grain and mash in the proportion of 1:1. All the lots were fed the same kind of grain which consisted of corn meal alone during the first 8 weeks and of corn and palay in the proportion of 1 part corn and 1 part palay by weight, thereafter.

The mash fed to each lot differed only in protein supplements. The mash used for each lot, during the first twelve weeks, consisted of the following ingredients, all by weight.

	LOT 1	LOT 2	LOT 3	LOT 4	LOT 5
Rice bran	6	6	6	6	6
Corn meal	2	2	2	2	4
Shrimp meal	2	—	—	—	—
Meat scraps	—	2	—	—	—
Tankage	—	—	2	—	—
Fish meal	—	—	—	2	—

The analysis of each of the supplements used is given in the following table. These analyses were supplied by the Department of Agricultural Chemistry of this College.

	SHRIMP MEAL	MEAT SCRAPS	TANKAGE	FISH MEAL
	per cent	*per cent*	*per cent*	*per cent*
Moisture	14.55	5.97	9.42	9.56
Fat, (ether extract)	2.61	11.38	2.81	2.53
Ash	19.73	26.13	15.23	18.99
Protein (N × 6.25)	55.61	51.91	63.81	57.99
Crude fiber	4.20	1.58	1.04	0.23
Carbohydrates	3.26	2.48	0.66	11.58

After the chicks had been weaned from the brooder, the following mash mixtures were used:

	LOT 1	LOT 2	LOT 3	LOT 4	LOT 5
Rice bran	4	4	4	4	4
Copra meal	3	3	3	3	3
Corn meal	2	2	2	2	3
Shrimp meal	1	—	—	—	—
Meat scraps	—	1	—	—	—
Tankage	—	—	1	—	—
Fish meal	—	—	—	1	—

Calculated on the current prices in the local market at the time that these experiments were conducted, the cost of the rations used was:

LOTS	KIND OF SUPPLEMENT	COST OF 100 KGM. OF RATION	
		Chick ration	Rearing ration
		pesos	*pesos*
Lot 1	Shrimp meal	6.23	5.60
Lot 2	Meat scraps	7.03	6.00
Lot 3	Tankage	6.83	5.90
Lot 4	Fish meal	6.01	5.49
Lot 5	None	4.86	4.91

In all the trials, on the second day after the chicks were hatched they were given finely ground feed. During the first week of the experiment in all the tests, all lots were given the same kind of feed; this was rice bran and corn meal mixed with finely chopped hard-boiled duck eggs. After the first week, each lot was given the kind of mash feed prescribed for it. The mash feeds for all the lots were given in open mash troughs to which the birds had free access at all times. Drinking water, changed four times a day, was accessible to the birds all the time. The three months the chicks were confined in separate compartments in the poultry laboratory, they were given green feeds every day.

Records. The chicks were weighed weekly from the first day of the experiment till the end of the twenty-fourth week and their weights recorded. The amount of feeds consumed by each lot was also carefully recorded. Mortality records of each lot were kept. The feathering condition of the birds in each lot was carefully observed. The date of the time of maturity of the pullets in each lot was observed and recorded.

RESULTS AND DISCUSSIONS

Growth. It may be seen in table 1 and chart 1 that in all lots studied the weights of the chicks at the beginning of the experiment were practically the same. At the age of one week (see table 1), the average weights of the chicks in each lot were still practically the same. This may be due to the fact that the chicks in each lot were fed the same kind of feed the first week. From the second week to the twelfth week of age, however, differences in the rate of growth between the chicks in each lot can be noted in the same table. In the third week, the chicks in the shrimp meal lot more than doubled

their initial weight; but those in the meat scraps lot did not quite double their initial weight. The chicks in the tankage lot did not double their initial weight until about the fourth week; the chicks

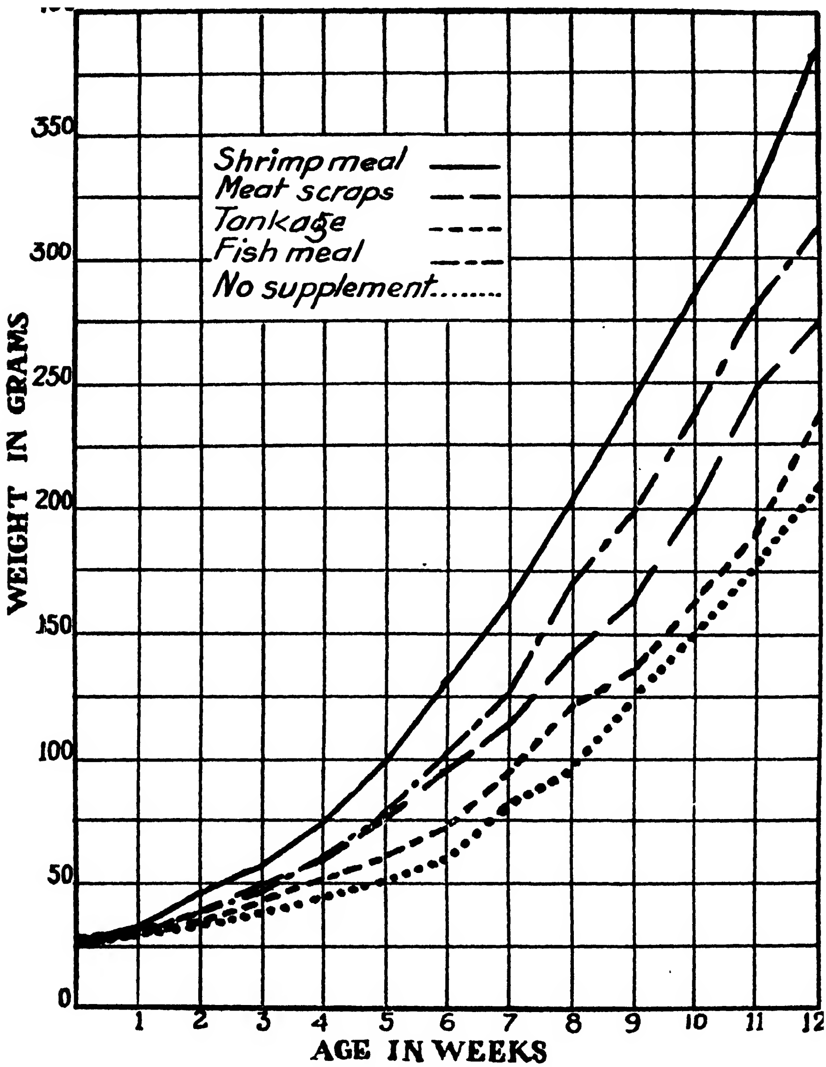

Chart 1.—Showing comparison of the rate of growth of the chicks in all lots studied to the age of 12 weeks.

in the fish meal lot doubled their initial weight during the third week. The initial weight of the chicks in the check lot was not doubled until the fifth week.

It may be seen in the table that at the age of twelve weeks the chicks in the shrimp meal lot were the heaviest and those in the check lot the lightest. These figures show that in comparison with the rest of the lots shrimp meal produced the fastest growth. The slowest growth was noted in the check lot where no protein supplement was added to the ration. The fish meal lot was second to the dried shrimps; the meat scraps lot, third; and the tankage lot, fourth. The chicks in the tankage lot were only slightly heavier than those in the check lot. With only one or two isolated exceptions, similar

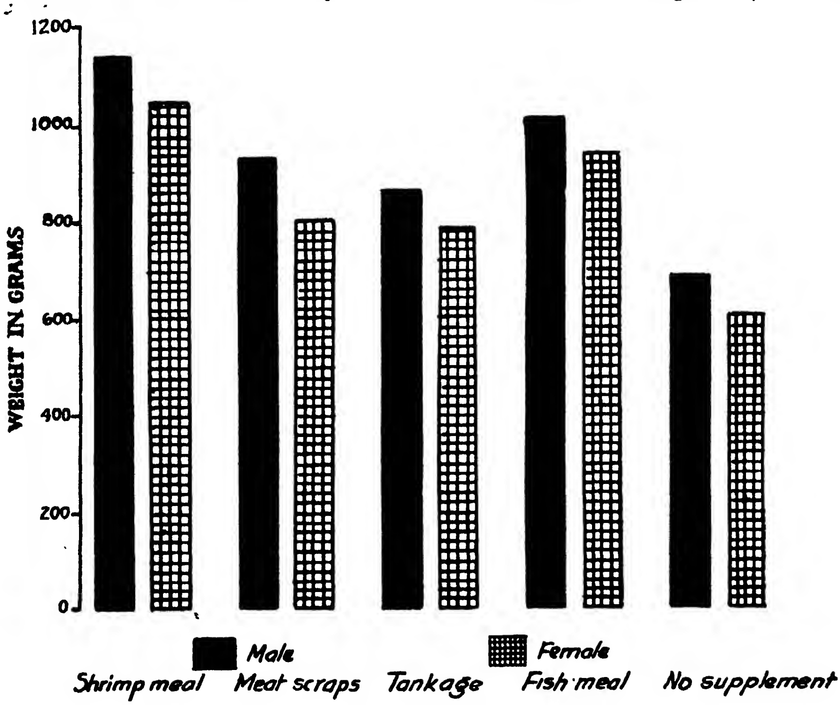

Chart 2.—Showing the comparative sizes of the chickens in all lots at the age of 6 months.

relationships in the average weights of the chicks were observed in all the trials made in this study.

When the sex of the birds could be determined, the average weekly growth of the male and the female birds that survived to twenty-four weeks was separately recorded. The data obtained showed the same results, that is, those that received shrimp meal as supplement, were the heaviest, followed by those that received the fish meal. Those that received the meat scraps and tankage were lighter than the birds in the fish meal lot. The lightest birds were

those that did not receive any protein supplement in the ration. The differences in the size of the birds in the different lots are clearly shown in chart 2.

These differences in the rate of growth of the chickens in all the lots studied are due mainly to the effects of the feed given them inasmuch as all the lots were given the same care and management throughout the experiment. The superiority of the shrimp meal and the fish meal lots over the other lots may be due to the composition of these feeds and to their palatability to the birds. The birds in the meat scraps lot were only a little better than those in the tankage lot. Although tankage may have a toxic effect when fed to chicks, as reported by McFarlane, Graham and Hall (1931), the birds grew nearly as rapidly as the birds fed with meat scraps. According to Sherwood (1924) who made a study on the comparative influences of the various protein feeds on laying hens, a ration containing tankage was observed to be as palatable as the ration containing meat scraps. The check lot, lot 5, which had no protein supplement, made the slowest growth.

Amount and cost of feeds. Table 2 shows the amounts of feed consumed by the chickens in the different lots at different ages. These were computed on the basis of 100 birds so that comparison may be made directly. To produce 100 weanlings it was observed that it required 221.9 kgm. of feed for the shrimp meal lot, lot 1; 203.9 kgm. for the meat scraps, lot 2; 178.6 kgm. for the tankage, lot 3; 212.2 kgm. for the fish meal, lot 4; and 164.2 kgm. for the no-supplement lot, lot 5. The same relationship in the amount of feed consumed by the birds in the different lots was observed from the age of thirteen weeks to twenty-four weeks. It is apparent that the chickens in the shrimp meal lot consumed the greatest amount of feed to produce 100 birds to laying age and the chicks in the no-supplement lot consumed the least.

The superiority of the shrimp meal lot over the other lots with regard to feed consumption can be explained as probably due to the palatability of the ration. The fish meal lot ranked second; the meat scraps lot, third; the tankage lot, fourth; and the check lot, fifth. Tuason and Fronda (1924) in their work on the availability and palatability of Philippine poultry feeds reported that among the ground feeds, dried shrimps (shrimp meal) was the most palatable, with ground dried fish as a close second. In the present studies, it was observed that the fish meal was relished by the birds, although not so much as the shrimp meal. The ration containing meat scraps

and tankage was not as much relished by the birds as the ration containing either shrimp meal or fish meal. It was observed that the birds in these two lots weakened readily, and showed little or no interest in their feed. The control lot consumed the least, probably because their ration was deficient in proteins, as no protein supplement was added to the ration.

Cost of production. Table 3 shows that the cost of feed per bird raised to twenty-four weeks of age in the meat scraps lot was only ₱0.05 less than that of the shrimp meal lot, although the amount of feed was much smaller; this was because of the higher cost of meat scraps. Although the cost of the rations in the tankage lot and the control lot was less than that of the shrimp meal lot, yet when the value of the birds raised is compared with the cost of feeds, it will be seen that the shrimp meal lot was the most economical. The fish meal lot followed a close second; the meat scraps and tankage lots were practically the same and the no-supplement lot was the least economical.

Table 3 also shows that it required only ₱0.30 worth of feeds to raise one bird from weaning to twenty-four weeks old in the shrimp meal lot. This is lower than the figures reported by Amon (1930) using the same supplement. And Paje (1927) reported a feed cost per bird of ₱0.38. The difference in feed cost may be due to the lower cost of the rations at the time the present study was conducted. The birds in the meat scraps lot each required ₱0.25 worth of feeds from weaning to twenty-four weeks of age. This is practically the same as that of the fish meal lot. The tankage lot consumed feeds costing only ₱0.23 and the no-supplement lot, ₱0.16.

Mortality. Table 4 shows the summary of percentages of mortality in the five lots. It may be seen from this table that although the mortality in all lots during the brooding period was high, the results seem to show that chicks fed with rations lacking in protein supplement can not grow well. The check, or no-supplement lot recorded the highest percentage of mortality, with the tankage lot ranking second, the fish lot, third, the meat scraps lot, fourth and the shrimp meal lot, the least.

The percentage of mortality in all the lots was rather high. This may be because these chicks were brooded during the rainy months of the year, hence conditions for brooding were unfavorable. In addition to the differences in their rations which may have caused the death of the chicks, part of the high percentage of mortality may be attributed to the typhoons and heavy rains that occurred during the

time the experiment was conducted. A number of the chicks died from the effects of getting chilled in rainy weather. But even then the differences in mortality of the chicks in the different lots studied were very significant. That chicks in the shrimp meal lot were hardy and resistant was shown by the low mortality recorded in this lot, the lowest of the five. Very few cases of roup were noted in this lot, while the chicks in lots, 2, 3, 4 and 5 were less resistant, hence, more susceptible to this trouble.

The high percentage of mortality in the check or no-supplement lot may be accounted for by the absence of protein supplement in the ration. It is universally accepted by competent investigators that protein concentrates are necessary in the nutrition of chickens. The results obtained in the tankage and meat scraps lots corroborate the conclusions reported by McFarlane, Graham, and Hall (1931).

Maturity. Table 5 shows the maturity of pullets raised to twenty-four weeks of age in all the lots studied. It may be seen in this table that the minimum age when the first egg was laid was 163 days and this was by a pullet in the shrimp meal lot. This figure is about the same as that reported by Amon (1930) which is 160 days, but higher than that reported by Dañgilan (1926) which is 128 days. It is, however, lower than that reported by Mendoza (1925) which is 174 days. Such differences as are found in the present study may be due to differences in the rations used and to environmental factors. The present study was conducted during the off season, while Amon and Dañgilan conducted their experiments during the favorable season. The pullets of the check lot matured the latest. According to Ordoveza (1927) December hatched pullets matured earlier than the April hatched ones and the February hatch matured the latest.

Referring to the same table, it may be seen that the percentage of pullets laying at twenty-four weeks of age in the shrimp meal lot was 31.2 per cent; in the meat scraps lot, 11.1 per cent; in the tankage lot, 10.8 per cent; in the fish meal lot, 35.0; and in the check lot, 0 per cent. These figures show that the fish meal lot had the highest percentage of pullets laying at the age of twenty-four weeks. This was followed very closely by the lot fed with shrimp meal. The meat scraps lot and tankage lot had practically the same number of pullets laying at the age of twenty-four weeks. In the check lot, no pullet laid eggs at the age of twenty-four weeks.

Comparing the lots in the number of eggs collected when the pullets were twenty-four weeks of age, it may be seen from the same table that the shrimp meal lot had 97 eggs to its credit, this being the

greatest number of eggs collected; meat scraps, 14; tankage, 10; and fish meal, 11. All of these differences, length of maturity, percentage of flocks laying at twenty-four weeks of age and total number of eggs collected in each lot were probably due to the effects of the supplements given to the birds, for all the birds were subjected to practically the same condition of care and management.

Other observations. Feathering of the birds. The feathering of the birds in all the sets for each lot was closely observed. It was observed that the appearance and growth of feathers in the chicks is influenced by the feeds. For instance, the feathers of the chicks in the shrimp meal lot were observed to grow earlier than the rest of the lots. The appearance of the feathers in the fish meal lot followed the shrimp meal lot very closely. The meat scraps lot ranked third as to the appearance of the feathers while the tankage and control lots were very late and slow.

Cannibalism. A very peculiar habit was observed in the tankage and control lots in which cannibalism was prevalent among the chicks while they were young. These chicks were observed to pick the toes of each other. This habit observed among the chicks in the tankage lot corroborates the report of McFarlane, Graham, and Hall (1931) who observed that chicks fed with tankage practiced cannibalism and toe picking. In this connection, it may be mentioned that the pullets in the tankage lot ate their eggs if they were not removed at once from the nest. This habit was not observed in the other lots.

SUMMARY OF CONCLUSIONS

The effects of shrimp meal, meat scraps, tankage and fish meal as supplements in rations for growing chickens were studied. From the figures obtained the following summary may be presented:

1. The ration supplemented with shrimp meal produced much more vigorous chicks than the rations supplemented with either fish meal, meat scraps, or tankage.

2. The birds in the shrimp meal lot were the largest, and those in the no-supplement lot were the smallest. The birds in the fish meal lot, and those in the meat scraps and tankage lots ranked second, third and fourth in size.

3. Chicks fed with ration supplemented with either meat scraps or tankage were rather unthrifty in their growth.

4. Of all the supplements tested, shrimp meal was the most palatable. The addition of tankage to the ration of chicks probably made the ration unpalatable.

5. It was apparent that the shrimp meal was the most economical and most profitable supplement used, fish meal was second, meat scraps was third, and tankage, fourth.

6. The brooding mortality of chicks in the shrimp meal lot was almost normal. In this experiment tankage caused high percentage of mortality.

7. Shrimp meal stimulated the appearance and growth of feathers of the chicks.

8. The birds fed with a ration supplemented with shrimp meal matured earlier than the birds fed with either meat scraps or tankage. The birds fed with a ration where no protein supplement was used matured very late.

9. There was no appreciable difference in the maturity of pullets in the meat scraps and the tankage lots.

10. Cannibalism was prevalent among the chicks fed with the tankage and no-protein supplement rations.

11. It is not advisable to raise chickens with no protein supplement for it causes high percentage of mortality and the growth is slow.

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TABLE 1

Showing average weekly weights of chicks in all the lots raised to 12 weeks old

AGE	LOT 1 (SHRIMP MEAL)		LOT 2 (MEAT SCRAPS)		LOT 3 (TANKAGE)		LOT 4 (FISH MEAL)[a]		LOT 5 (NO SUPPLEMENT)	
	Number of birds	Av. weekly wt.	Number of birds	Av. weekly wt.	Number of birds	Av. weekly wt.	Number of birds	Av. weekly wt.	Number of birds	Av. weekly wt.
		grams		*grams*		*grams*		*grams*		*grams*
1 day	148	25.8	148	25.7	148	26.0	80	24.4	148	25.9
1 week	148	30.4	148	30.2	148	30.2	80	30.4	148	29.3
2 weeks	141	44.6	140	39.8	140	37.0	71	38.5	140	33.9
3 "	139	55.7	138	49.9	138	44.7	68	47.8	124	39.7
4 "	132	74.4	134	58.3	119	52.5	58	63.6	91	45.1
5 "	119	98.4	116	75.4	93	60.2	51	77.5	66	51.2
6 "	116	127.6	101	95.2	74	72.6	42	102.6	46	60.3
7 "	115	162.0	95	114.9	65	94.4	42	126.8	37	77.8
8 "	113	203.7	90	142.3	55	120.8	40	171.2	28	97.6
9 "	113	236.2	87	163.1	51	134.9	37	194.9	24	125.1
10 "	113	280.3	81	200.3	45	162.2	37	238.4	20	150.0
11 "	112	324.5	83	246.2	43	189.2	37	280.2	20	179.0
12 "	112	386.5	82	272.7	42	236.6	35	312.9	20	210.5

[a] There were only two sets conducted in this lot.

TABLE 2

Showing the amount of feeds consumed by the different lots, computed per 100 birds

LOT NO.	1-12 WEEKS			13-24 WEEKS			TOTAL		
	Grain	Mash	Total	Grain	Mash	Total	Grain	Mash	Total
	kgm.	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*
Lot 1 (Shrimp meal)	106.7	115.2	221.9	256.3	273.1	529.4	363.0	388.3	751.3
Lot 2 (Meat scraps)	99.6	104.3	203.9	200.6	215.1	415.7	300.2	319.4	619.6
Lot 3 (Tankage)	91.7	86.9	178.6	177.9	194.5	372.4	269.6	281.4	551.0
Lot 4 (Fish meal)	103.7	108.5	212.2	230.1	252.4	482.5	333.8	360.9	694.7
Lot 5 (No supplement) ..	81.5	82.7	164.2	149.4	168.9	318.3	230.9	251.6	482.5

TABLE 3

Showing the cost of producing 100 birds raised to 24 weeks

ITEMS	LOT 1	LOT 2	LOT 3	LOT 4	LOT 5
	pesos	*pesos*	*pesos*	*pesos*	*pesos*
Cost of feeds, 1–12 weeks	13.95	14.44	12.11	12.82	7.99
Cost of feeds, 13–24 weeks	29.77	25.11	23.13	26.63	15.66
Total	43.72	39.55	35.24	39.45	23.65
Value of birds [a]	87.69	69.72	65.54	76.79	51.41
Value of birds over cost of feed	43.97	30.17	30.30	37.34	27.76
Cost of feeds per bird raised to 12 weeks old	0.14	0.14	0.12	0.13	0.08
Cost of feeds per bird raised to 24 weeks old	0.44	0.39	0.35	0.39	0.24

[a] The birds were valued at ₱0.80 per kgm. live weight.

TABLE 4

Showing the summary of percentages of mortality in the different lots

LOT NO.	NUMBER OF BIRDS			PERCENTAGE MORTALITY		
	Start	12 weeks	24 weeks	To 12 weeks	13-24 weeks	Total [a]
Lot 1 (Shrimp meal) ...	148	112	106 [b]	24.4	5.3	28.4
Lot 2 (Meat scraps)	148	82	72	44.6	12.2	51.3
Lot 3 (Tankage)	148	42	42	71.6	0	71.6
Lot 4 (Fish meal)	80 [c]	35	35	56.2	0	56.2
Lot 5 (No supplement) .	148	20	18	86.5	10.0	87.8

[a] Based on original number of birds at beginning of experiment.
[b] Three birds were stolen.
[c] There were only two sets in the fish meal series.

TABLE 5

Showing the maturity of pullets raised to twenty-fourth week in each lot

ITEMS	LOT 1	LOT 2	LOT 3	LOT 4[a]	LOT 5
Number of pullets raised to 24 weeks	48	36	27	20	10
Minimum age when first egg was laid	163 da.	177 da.	181 da.	——[b]	203 da.
Number of pullets that had laid at 24 weeks of age	15	4	3	7	0
Per cent of flock laying at 24 weeks of age ...	31.2	11.1	10.8	35.0	0
Number of eggs collected to 24 weeks of age ...	97	14	10	11	0

[a] There were only two sets conducted in this lot.
[b] Not recorded.

ABSTRACT [1]

The coconut industry in Pila, Laguna. FELIXBERTO RELOVA. (*Thesis presented for graduation, 1929, with the degree of Bachelor of Science in Agriculture from the College of Agriculture No. 373; Experiment Station contribution No. 924.*)—The main object of this work was to study the coconut industry of Pila, Laguna with respect to methods of culture, costs, and yield of trees under different conditions. The work was carried out by interviewing landlords and tenants who had had long years of experience in coconut planting. The data on the expenses of the different operations and yields of nuts were taken from the records of the plantations of any size in all the important coconut barrios of the town. [2]

The results obtained by the author are summarized as follows:

1. Clearing of forest lands is done by contract at prices varying from ₱40 to ₱70 a hectare. Expenses for removing the stumps run from ₱10 to as high as ₱12 a hectare.

2. Open areas, especially those covered by cogon, were plowed after a rainy season and again before the rainy season preceding planting them to coconut. Including harrowing, the cost of this tillage was ₱24 a hectare.

3. In Pila, little attention is given to seed selection. Planters, however, take their planting materials from piles of large nuts.

4. Seedlings are transplanted when they are about 80 cm. tall or as soon as they have developed three to four leaves.

5. The plants are set in the field in squares. The distance between plants is 6 to 7 meters in old plantations and 8 meters in the new ones. Holes are dug about 60 cm. in diameter and 30 cm. deep.

6. Harvesting is done every two months, ordinarily, but in the rainy season the interval is only about one and one half months. It is done with a *halabas*. This tool is a very light and small but strong bamboo pole three meters long with a knife the shape of an ordinary

[1] Abstract prepared as part of the required theme work in English 3a, College of Agriculture.

[2] It should be borne in mind that this study was made four years ago and cost data may not hold good at present on account of change in economic conditions in the country. N. B. M.

as acids. In makes wood, concrete, and other porous materials completely waterproof. Completely dry S.D.O. surfaces will withstand a temperature as high as 400 degrees Fahrenheit.

Tropical Life, June, 1933.

The avocado should be cleft grafted, and, after stock and scion have been well bound together, the whole should be covered with a cardboard or paper cap or cylinder of sufficient length to cover the cleft. This should ensure a very high percentage of success. (*Horticultural Abstracts*, Vol. II, No. 3).

Reprinted in *Tropical Agriculture* (Trinidad, B. W. I.), April, 1933.

True bud-rot, has never been recorded on coconut palms in Malaya, and no definite root disease of coconuts has, so far, been found in this country.

The fungus Phytophthora has been shown to cause epidemic bud-rot of the coconut palm in India and in the Philippines, but, although strains of this fungus are present in this country on rubber and other plants, the fungus has never been recorded on palms in Malaya....

Bud-rot of the oil palm is a well-known disease on Malayan plantations, and in this disease one can usually find evidence of injury to the bud by mechanical or insect agency, and the disease differs from coconut bud-rot in that affected palms usually recover.

A definite parasitic micro-organism has not been found in association with oil palm bud-rot, and, in the case of coconut palms, no organisms have been found to be primarily responsible for the only form of "bud-rot" recorded in Malaya.

It has now been established that, in Malaya, the cause of this form of "bud-rot", which affects coconut palms, is injury by lightning. The symptoms of the "disease" do not resemble true bud-rot as reported from other countries, since the central leaves and the bud are usually only affected after the outer leaves have died.

Malayan Agricultural Journal, (S. S. & F. M. S.) July, 1933.

Reports recently published of insect and other foods needed by the London Zoo, say that 476 lb. of dried flies or over a fifth of a ton are needed. Other choice morsels for those who like them included 686 lb. of meal worms and 448 lb. of ants' eggs. How many ants' eggs go to the lb., and again how is so large a quantity obtained, to say nothing of further supplies put up in (one corner of) wooden boxes and sold to feed goldfish? Do the fish ever eat them? We have our

doubts and gave up buying them years ago, i.e., 2 years out of the 2¼ years that "we" have had three gold fish in a pond. Where the tropics and sub-tropics may become interested in these menus for the inhabitants of the Zoological Gardens of London is when they include fruit, such as: 184,076 bananas, 79 cwt. locust beans, 14,689 oranges, 19 qrs. sunflower seeds, 357 lb. sugar, 142 lb. Brazil nuts, 201 lb. golden syrup, 7 tons 6½ cwt. apples, 10¾ cwt. currants (we suppose dried). Who supplies all these, to say nothing of 46 tons of fish and 1,914 pints of shrimps. Are the shrimps alive, if not, are they peeled?

Tropical Life, May, 1933.

COLLEGE AND ALUMNI NOTES

On November 15 Dr. Jacob Gould Schurman, President Emeritus of Cornell University, spent several hours on the Campus. He was accompanied by his grandson, Mr. Jacob Gould Schurman III and Cornellians from Manila and Canlubang Sugar Estate. He gave a short address in the Auditorium which was more than packed with students and faculty members. Doctor Schurman told of the beginnings of the College of Agriculture in Cornell University on his recommendation and under his personal administration forty-one years ago. It was one of the first institutions of the kind in the United States. Of the three principal aims of the college, research, training teachers of agriculture and extension work, the most useful, he believed, was the last. Doctor Schurman spoke of the economic conditions in the world, but especially in the United States, and in line with other thinkers of the day expressed the belief that we are in the transition period between a passing and a new era of civilization. In the coming era the farmer, the producer will, he prophesied, be the important man rather than the manufacturer, as in the past century.

Doctor Schurman and his party were guests at a luncheon at Molawin Hall. Here, in response to a toast in his honor, Doctor Schurman spoke briefly on academic freedom in a college, making very clear where *noblesse oblige* placed a limit. Other speakers were Doctor Copeland, Dean Gonzalez, Doctor Mendiola, the last being the first graduate from this College to receive a degree from Cornell. Doctor Manresa, Chairman of the Committee on Social Affairs, was toastmaster.

It is of interest in this College that Doctor Schurman was a member of the First Philippine Commission. He was also Minister to China and Ambassador to Germany, making an enviable record in each country.

In the evening of October 26 in the College Auditorium the SAR (Society for Advancement of Research) held open meeting for initiation of new associate members. The men, undergraduates, so honored were Porfirio Manacop and Dennis Molintas.

It is the custom of the SAR at initiation of members to invite a scientist of note to make the address of the evening. The address on this evening was by the Reverend Miguel Selga, S. J., Director of the Weather Bureau. His subject was "The Mechanical and Physical Aspects of Philippine Oceanography".

It was a masterly address. Even one with little interest in the subject was soon an absorbed listener, so clearly, so simply, so ably were the phases of the subject presented.

Dr. G. O. Ocfemia, President of SAR presided and conducted the initiation. Dean Gonzalez introduced Father Selga.

The eighty-seventh regular scientific meeting of the Los Baños Biological Club was held in the Lecture Hall of the Poultry Building, College of Agriculture, on Thursday, October 19, 1933, at 7:30 p.m.

The following papers were read and discussed:

1. "Protein supplements in poultry ration: II. Comparative effects of shrimp meal, meat scraps, tankage, and fish meal as supplements in rations for laying hens."

   By Dr. F. M. Fronda, Mr. Alfredo A. Francisco and Mr. Gregorio S. Chan. (Paper read by Mr. Chan)

2. "Common Philippine bamboos. Their structure and identification."

   By Forester Luis J. Reyes

The Los Baños Chapter of Rizal Center fraternity held its second initiation for this academic year on October 21. The following neophytes were initiated into the mysteries of the fraternity:

Alejandro R. Apacible, Enrique M. Bautista, Dominador Batenga, Jose E. Borromeo, Felix de Leon Flores, Pablo C. Macariola, Porfirio R. Manacop, Harry Varian.

Rizal Center is the oldest and best known fraternity in the University of the Philippines. It has fraternity chapters in Manila, Los Baños and Cebu and a sorority chapter in Manila.

Mr. Jose Quintos '33 was a Campus visitor recently. He is trying his hand at farming and chicken raising—with improved breeds—near Vigan, Ilocos Sur.

In the evening of November 11, at the Center the Rural High School under the direction of Mrs. Harriett Richards of the High School staff presented the following program.

Selection	The Orchestra
The Spanish Guitar (Song by Male Quartette)	M. Visperas
	E. Palis
	M. Matias
	E. Ramirez
Accompanied on guitar by	A. Apolinario
Alouette (French-Canadian Folk Song)	I. Maniñgas
By Mixed Quartette	E. San Luis
	T. Ocampo
	S. Lawas
	M. Visperas
	E. Palis
	E. Lawas
	S. Ramirez

The Turtle Dove (A Chinese Fantasy in one act, two scenes)

Characters in order of appearance:

Gong bearer	Jose De Mesa
Chorus	Abelardo Mondoñedo
Chang Sut Yet (The Turtle Dove)	Apolinario Medel
Mandarin	Quintin Abrenica
Kwen Lin (Mandarin's Daughter)	Ruperta Gesmundo
Property Man	Agapito Gonsalvo
God of Fate	Lif Roa

The youthful actors merit praise for their interpretation of this play, so typically Chinese in poetic conception. Chinese costumes lent by a Chinese theater in Manila added much to the pictorial and artistic effect.

The College Secretary reports the enrollment for the second semester as follows:

Freshmen (1st Year Collegiate)		119 students
B. S. A., General Curriculum	114	
B. S. S. T. Curriculum	5	
Sophomores (2nd Year Collegiate)		68 students
B. S. A., General Curriculum	61	
B. S. S. T. Curriculum	7	

Juniors (3rd Year Collegiate)		98 students
B. S. A., General Curriculum	55	
B. S. A., Ani. Hus. Curriculum	15	
B. S. A., Supp. Curriculum	2	
B. S. S. T., Curriculum	4	
B. Agr., General Curriculum	21	
B. Agr., Ani. Hus. Curriculum	1	
Seniors (4th Year Collegiate)		136 students
B. S. A., General Curriculum	66	
B. S. A., Ani. Hus. Curriculum	22	
B. S. A., Supp. Curriculum	3	
B. S. S. T. Curriculum	7	
B. Agr., General Curriculum	35	
B. Agr., Ani. Hus. Curriculum	3	
Graduate Students		10 students
Regular Graduate	1	
Special Graduate	9	
Special Students (Not candidates for degrees)		6 students
Total College Students		437 students
Cross registrations from:		
U. P. Rural High School		23 students
School of Forestry		18 students
Total registration		478 students

The *Index* for volume XXI of the PHILIPPINE AGRICULTURIST is now on sale. The price is ten centavos.

THE LOS BAÑOS BIOLOGICAL CLUB:[1]
TEN YEARS OF ACTIVE WORK IN RESEARCH

ORGANIZATION

It was on November 15, 1923, or a little over ten years ago, when, at the invitation of Dr. B. M. Gonzalez and Dr. L. B. Uichanco, nineteen men representing the Colleges of Agriculture and Veterinary Science and the School of Forestry, University of the Philippines, met in the Auditorium of the College of Agriculture to organize the Los Baños Biological Club. The members of the faculty who represented the College of Agriculture at this organization meeting were Dr. B. M. Gonzalez, Dr. L. B. Uichanco, Dr. R. B. Espino, Dr. N. B. Mendiola, Prof. D. A. Herbert, Dr. E. Quisumbing, Dr. M. L. Roxas, Dr. F. O. Santos, Dr. G. O. Ocfemia, Dr. F. M. Fronda, Dr. V. Villegas, Dr. T. Vibar, Mr. F. B. Sarao, Mr. E. Collado and the late Mr. Victor Sulit. The College of Veterinary Science was represented by Dr. A. K. Gomez and Dr. M. Manresa; the School of Forestry, by Prof. P. Dacanay and Mr. A. de Mesa.

This club is unique in that it has no written constitution, its affairs being guided by only a few rules of conduct which may be named thus: (1) This organization shall be called Los Baños Biological Club. (2) The object shall be to encourage biological research by promoting a common meeting ground among its members. (3) Membership shall include faculty members of the University of the Philippines residing in Los Baños who are interested in biology. (4) There shall be a president and a secretary to carry on the details of the work of the club. They shall hold office beginning each college year. (5) There shall be a nominating committee of three members appointed by the president who shall submit the names of the officers for the ensuing term at the last meeting of the club. (6) There shall be no reëlection of any officer who has served his full term. Only one other rule has been added to these since the organization of the club. On August 27, 1925 the members decided that no papers shall

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[1] General contribution from the College of Agriculture No. 394.
Read at the dinner on November 23, 1933 celebrating the Tenth Anniversary of the organization of the Los Baños Biological Club.

be read formally unless they embody the results of independent and original investigation and that work done locally shall have preference over that done elsewhere.

Dr. B. M. Gonzalez was elected President and Dr. L. B. Uichanco, Secretary for the year 1923-1925. In the years that followed the officers of the club have been: 1925-1926, Dr. N. B. Mendiola and Dr. M. Manresa [2]—Dr. M. A. Tubangui; 1926-1927, Dr. L. B. Uichanco and Dr. A. K. Gomez; 1927-1928, Dr. A. K. Gomez and Dr. F. M. Fronda; 1928-1929, Dr. R. B. Espino and Dr. V. Villegas; 1929-1930, Dr. F. O. Santos and Dr. G. O. Ocfemia; 1930-1931, Dr. G. O. Ocfemia and Dr. Z. de Jesus; 1931-1932, Dr. V. Villegas and Prof. C. Sulit; 1932-1933, Dr. F. M. Fronda and Prof. A. de Mesa; 1933-1934, Dr. M. Manresa and Dr. L. M. Yutoc [3]—Prof. P. Dacanay.

ATTENDANCE AT THE MEETINGS

Complete data on the number who attended the meetings of the club from the beginning are unfortunately not available. But from June, 1928 when Doctor Villegas became Secretary of the Club records were made of the attendance at each meeting of faculty members and students and those who attended occasionally and may be called visitors. This practice was continued by the succeeding secretaries. These records show a total attendance of 3,030 in the five consecutive years from June, 1928 to March, 1933. The number of faculty members attending the meetings in that period was 1,111, of students, 1,885. The average attendance at each meeting was 20 for the faculty and 38 for the students. The number of visitors was 2 for each meeting.

The staff of the Department of Agricultural Chemistry was most frequently seen in these meetings and that of the Department of Rural Economics the most infrequently. The Department of Animal Husbandry stood second to Agricultural Chemistry and the departments of Agronomy, Plant Pathology, the College of Veterinary Science, the School of Forestry and the Department of Entomology stood about even. The records also show that the highest attendance occurred in the months of November and January, the lowest in

[2] Resigned in August, 1925 having been appointed a Fellow of the University of the Philippines to take post graduate studies in the University of Wisconsin.

[3] Resigned in July, 1933 when the College of Veterinary Science was transferred to Manila.

June, December and March. In the matter of attendance as to months both faculty and students coincided almost exactly, that is, the highest months for the faculty were also the highest for the students and the lowest for the faculty were also lowest for the students.

ACHIEVEMENTS

During the past ten years the club met regularly. Since its organization a total of 91 scientific meetings have been held and of these, three were held jointly with other scientific societies, two with the Philippine Society of Parasitologists and one with the Laguna Medical Society. Under the auspices of the Los Baños Biological Club, Dr. Richard Goldschmidt, Director of the Kaiser Wilhelm Institut für Biologie, Berlin, Germany, gave a lecture in December, 1929 on the physiology of sex determination. In August, 1931, Dr. G. A. C. Herklots, Professor of Biology in the University of Hong Kong and Editor of the *Hong Kong Naturalist* discussed: "The effect of ethylene on the respiration of plant organs, leaves and fruits". Three months later (November, 1931) Professor L. R. Jones of the University of Wisconsin was the guest of the club. Professor Jones discussed the general subject of researches in plant pathology. And in May, 1932, Dr. Richard Woltereck, Professor of Zoology in the University of Leipzig, Germany, gave a lecture on: "Differentiation of animal species and races in islands and lakes".

The total number of scientific papers read at the meetings of the Club is 228 of which 170 were by single authorship and 58 were by joint authorship. One hundred and twenty-one workers collaborated in these joint authorship papers. That a fairly large group of research workers have taken an active part in supporting the life of the Los Baños Biological Club may be seen in the following table:

Table showing the names of those who read papers at the meetings of the Los Baños Biological Club from November, 1923 to November, 1933.

AUTHORS	CONTRIBUTIONS IN DIFFERENT YEARS																				TOTAL
	Single authorship										Joint authorship										
	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10	
1. Adriano, F. T.								1									1	2			4
2. Agati, J. A. . .	1	1																			2
3. Agudo, E. . . .																	1				1
4. Africa, C. . . .								1													1
5. Aldaba, V. C..			1																		1
6. Alonte, F. . . .																		1			1
7. Altamirano, G.									1												1

AUTHORS	CONTRIBUTIONS IN DIFFERENT YEARS																				TOTAL
	Single authorship										Joint authorship										
	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10	
8. Andres, P. N.																			1		1
9. Ang, I.																		1			1
10. Aragon, V. ..						1															1
11. Ascalon, A. V.																	1				1
12. Aquino D. I. .								1													1
13. Baker, C. F. .	1																				1
14. Baltazar, E. B.						1															1
15. Basio, E.									1												1
16. Bautista, E.M.																			1		1
17. Bayan, P. ...													1								1
18. Badelles, A.																			1	1	2
19. Buhay, R. ...									1												1
20. Buligan, C. T.																	1				1
21. Calma, V. C. .									1												1
22. Capco, S. R. .																				1	1
23. Capinpin, J.M.	1			1								1			1						4
24. Catambay, A.B.						1		1													2
25. Celino, M. S. .							1												1	1	3
26. Chan, G. S. .																				1	1
27. Collado, E. G.								1			1	1	1	2		1					7
28. Cruz, R. S. ..																		1	1		2
29. Cruz, S. R. ..																		1	1		2
30. Dacanay, P. .	1																				1
31. David, T. ...								1													1
32. Elayda, I. ...								1													1
33. Esguerra, J.P.																1					1
34. Espino, R. B.		1		1	1									1			1			1	6
35. Estioko, R. P.														1							1
36. Francisco, A.A.																				1	1
37. Francisco, S.A.												1				1		1			3
38. Fronda, F. M.	1	1	2		1			1						1	1		1		2	2	13
39. Galvez, N. L. .						1	1														2
40. Goldschmidt, R.			1																		1
41. Gomez, A. K.	1	2		1	1								1		1		1				8
42. Gonzaga, A. C.						1									1						2
43. Gonzalez, B.M.	2	1	3						1		1			1	1	1					11
44. Gonzalez, L. G.				1				1	1												3
45. Guanzon, G. .															1						1
46. Herbert, D. A.	1																				1
47. Herklots, G. A. C. ..								1													1
48. Higgins, J. E.	1																				1
49. Javier, R. Q..						1									1						2
50. Jesus, Z. de			1	1		1			1				1				1				6
51. Jones, L. R. .								1													1
52. Juachon, P. .																		1			1
53. Juliano, J. B.	1																				1
54. Kalaw, M. M.					1																1
55. King, R. H. .						1									1						2
56. Lago, F. P. .																					1
57. Lalog, N. P. .									1												1
58. Lava, V. C. ..						1															1
59. Leon, A. I. de																				1	1
60. Lumang, H.E.																			1		1

AUTHORS	CONTRIBUTIONS IN DIFFERENT YEARS																				TOTAL
	Single authorship										Joint authorship										
	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10	
61. Mabesa, C. ..										1											1
62. Mabbun, P. N.				1																	1
63. Mamisao, J. P.																				1	1
64. Manahan, M. (Miss)																	1				1
65. Manalang, C..							1														1
66. Mane, A. M. .						1		1													2
67. Manresa, M. .	1						1									1	1				4
68. Marfori, R. T.																			1		1
69. Mendiola, N. B.	2	1	1	2	1	1	3		1			1									13
70. Mendiola, V. (Miss)									1												1
71. Mercado, T. .					1							1			1			1			4
72. Mesa, A. de							1														1
73. Mondoñedo, M.				1		1				1			1					1			5
74. Montemayor, Z. T.					2																2
75. Ocfemia, G. O.	1	1	1				1		1		1								1		7
76. Pablo, A. D. .													1								1
77. Padilla, J. S. .																				1	1
78. Paje, P.																	1				1
79. Palo, M. A. ..		1		1																	2
80. Pantaleon, F. T.																				1	1
81. Pendleton, R. L.		1			1	1															3
82. Pepito, T. ...																	1				1
83. Peralta, F. ..			1					1									1				3
84. Pidlaoan, N. .							1											1			2
85. Quisumbing, E.	1	2																			3
86. Quisumbing, M.							1														1
87. Racelis, A. P..							1														1
88. Ramos, J. C. .					1																1
89. Raymundo, M. B.				1										1							2
90. Raymundo, R. A.							1										1				2
91. Reyes, L. J. .								1		1											2
92. Reyes, R.																				1	1
93. Reyes, T. P. .	1																				1
94. Robles, M. ...			1																		1
95. Rodrigo, P. A.		1	1	1																	3
96. Roldan, E. F.	2	1				1	1				1										6
97. San Agustin, G.	1	1	1												1						4
98. San Buenaventura, P..								1													1
99. San Pedro A..									1												1
100. Santos, F. O.	1				2						1	1	1	2		1		1	1	1	12
101. Sarao, F. B...					1											1	1				3
102. Schultz, C. H.	1	1																			2
103. Seguerra, J. .										1											1
104. Soliven, F. A.					1				1												2

AUTHORS	CONTRIBUTIONS IN DIFFERENT YEARS																				TOTAL
	Single authorship										Joint authorship										
	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10	
105. Sulit, C.							1														1
106. Sulit, M.							1	1	1												3
107. Taleon, A. T..																		1	1		2
108. Teodoro, A. L.	1	1				1													2	1	6
109. Tuason, C. ..																	1				1
110. Tubangui, M. A.	1	2	1	1	1							1			1	1					9
111. Uichanco, L. B.	1	2	1	1	1	1								1			1			1	10
112. Unite, J. O...												1									1
113. Vibar, T. ...		1		1																	2
114. Villadolid, D..					1	1															2
115. Villanueva, L. J.								1										1			2
116. Villegas, V. .		1			1	1							1	1			1	1	1		8
117. Woltereck, R..									1												1
118. Yutoc, L. M. .				1				1													2
119. Zamuco, C. T.					1																1

Of the total of 119 research workers who read papers at the meetings of the club, 67 contributed one paper each, 23 presented two papers each; 9, three papers; 5, four papers; 1, five papers; 4, six papers; 2, seven papers; 2, eight papers; 1, nine papers; 1, ten papers; 1, eleven papers; 1, twelve papers; and 2, thirteen papers.

The ten highest contributors were: *By single authorship;* (1) Dr. N. B. Mendiola, 12 papers; (2) Dr. B. M. Gonzalez, 7 papers; (3) Dr. L. B. Uichanco, 7 papers; (4) Dr. F. M. Fronda, 6 papers; (5) Dr. M. A. Tubangui, 6 papers; (6) Dr. A. K. Gomez, 6 papers; (7) Mr. E. F. Roldan, 5 papers; (8) Dr. G. O. Ocfemia, 4 papers; (9) Dr. Z. de Jesus, 4 papers; (10) Dr. R. B. Espino, 3 papers. *By joint authorship;* (1) Dr. F. O. Santos, 9 papers; (2) Dr. F. M. Fronda, 7 papers; (3) Mr. E. G. Collado, 6 papers; (4) Dr. V. Villegas, 5 papers; (5) Dr. B. M. Gonzalez, 4 papers; (6) Dr. R. B. Espino, 3 papers; (7) Dr. A. K. Gomez, 3 papers; (8) Dr. L. B. Uichanco, 3 papers; (9) Dr. A. L. Teodoro, 3 papers; and (10) Mr. T. Mercado, 3 papers.

The highest in total contributions were: Dr. N. B. Mendiola and Dr. F. M. Fronda with 13 papers each; Dr. F. O. Santos, 12 papers; Dr. B. M. Gonzalez, 11 papers; Dr. L. B. Uichanco, 10 papers; Dr. M. A. Tubangui, 9 papers; Dr. A. K. Gomez and Dr. V. Villegas, 8 papers each; Dr. G. O. Ocfemia and Mr. E. Collado, 7 papers each; Dr. R. B. Espino, Dr. A. L. Teodoro, Mr. E. F. Roldan and Dr. Z. de

Jesus, 6 papers each; Dr. M. Mondoñedo, 5 papers; Dr. F. T. Adriano, Dr. J. M. Capinpin, Dr. M. Manresa, Mr. T. Mercado and Dr. G. San Agustin, 4 papers each, etc.

The number and kind of papers read during each academic year and the nature of these papers are shown in the following table:

Table showing the number and kind of papers read at the meetings of the Los Baños Biological Club from November, 1923 to October, 1933.

Academic year	Agric. Engineering	Agronomy	Animal Husbandry	Agric. Chemistry	Entomology	Plant Pathology	Plant Physiology	Soils	Medical Division	Agric. Economics	Forestry	Veterinary Science	General Medicine	Parasitology	Miscellaneous	Total
1923-24			2		1	1	2				1	4				11
1924-25	1	5	2	2	1	3	2					1				17
1925-26	1	5	3	1	2	4	3	1	1			6				27
1926-27		3	7	1	1	1	1					5				19
1927-28		7	3	2	2	1	2			1		4				22
1928-29		8	4	4	2		1	1				5			1	26
1929-30	2	3	3	3	3	1		1	1			3				20
1930-31		3	4	2	2	3	1				4	2	3	1		25
1931-32	2	2	3	6	2		1	2			3	2		1	2	25
1932-33	2	4	5	4		3					4	1			1	24
1933-	1		3	2	1	1	1				3					12
Total . .	9	40	39	28	15	18	14	5	2	1	15	33	3	2	4	228

Such a signal accomplishment in the short span of the ten years' life of the Los Baños Biological Club should make all those who have helped to promote this active interest in research feel highly gratified. And it seems quite appropriate that we gather here this evening to make this Tenth Anniversary Celebration a memorable event. Let us hope that the next ten years may achieve even more than the past ten.

LIST OF PAPERS READ BEFORE THE LOS BAÑOS BIOLOGICAL CLUB

Department of Agronomy

1. Dr. N. B. Mendiola. Pineapple hybrids produced at the College of Agriculture. July, 1924.
2. Prof. J. E. Higgins. Refrigeration of mangoes. October, 1924.

3. MR. JOSÉ M. CAPINPIN. Seedling types of rosal (*Gardenia florida* L.) and their modified Mendelian ratios. November, 1924.
4. DR. N. B. MENDIOLA. Protandrously self-sterile flowers of Hibiscus rendered fertile by surgical operation. December, 1924.
5. MR. T. P. REYES. Change of sex-expression in papayas as a result of mutilation. February, 1925.
6. MR. P. A. RODRIGO. A case of polyembryony in rice. June, 1925.
7. DR. N. B. MENDIOLA. Heritable characters of Hibiscus: I. Presence or absence of lobes on juvenile leaves. September, 1925.
8. DR. T. VIBAR, AND MR. P. A. RODRIGO. The vitality of farm crops seeds as affected by different methods of storage. November, 1925.
9. DR. N. B. MENDIOLA, AND MR. T. MERCADO. Sugar cane breeding in the College of Agriculture: IV. Training sugar cane plants for convenient pollination work. December, 1925.
10. MR. J. O. UNITE, AND MR. J. M. CAPINPIN. Selection of mosaic-free cuttings of sugar cane. January, 1926.
11. DR. VICENTE C. ALDABA. Differentiation of Canton fiber from abaca. July, 1926.
12. DR. N. B. MENDIOLA. Natural crossing in rice and its relation to rice improvement. August, 1926.
13. MR. PEDRO A. RODRIGO. Production of peanuts from cuttings. December, 1926.
14. MR. PEDRO A. RODRIGO. Studies on the correlation between grain and straw production of cowpeas. July, 1927.
15. PROF. M. B. RAYMUNDO. The use of drill in the planting of rice. August, 1927.
16. DR. N. B. MENDIOLA. New plant immigrants in the College of Agriculture. September, 1927.
17. DR. T. VIBAR. Double dwarf milo, a new and promising Philippine crop. November, 1927.
18. DR. N. B. MENDIOLA. A brief report on an agricultural investigation trip to Java, Federated Malay States and Borneo. January, 1928.
19. DR. L. G. GONZALEZ. Removal of astringency in chico. February, 1928.
20. MR. J. M. CAPINPIN, AND MR. T. MERCADO. Pineapple breeding in the College of Agriculture. March, 1928.
21. MR. TORIBIO MERCADO. A report on the asexual inheritance of "many-eyed" character of sugar cane. August, 1928.
22. MR. ZOSIMO MONTEMAYOR. A promising cassava grater for the farm. September, 1928.
23. MR. ZOSIMO T. MONTEMAYOR. Methods of vitalizing agricultural teaching. November, 1928.
24. MR. JOSÉ C. RAMOS. First-year rotation of tobacco, corn and mungo. January, 1928.
25. MR. T. MERCADO, AND MR. J. M. CAPINPIN. Asexual inheritance of twin character of banana bunches. March, 1929.

26. DR. N. B. MENDIOLA. Ancestry of important College of Agriculture seedling cane varieties as suggested by Jeswiet characters. December, 1928.
27. MR. M. M. KALAW. Observations made on some coconut plantations in the Visayas. December, 1928.
28. MR. EULALIO P. BALTAZAR. The textile industry in the Ilocos provinces. September, 1928.
29. MR. VICENTE B. ARAGON. Ramai rice variety and its culture in Central Luzon Agricultural School. November, 1929.
30. DR. N. B. MENDIOLA. An illustrated guide to the collections of economic and ornamental plants in the College of Agriculture. November, 1929.
31. MR. CALIXTO T. ZAMUCO. Composition of natural pastures with special reference to climate. March, 1929.
32. DR. N. B. MENDIOLA. About Philippine New Guinea 24-A and Barbados 147 canes. September, 1930.
33. DR. LEON G. GONZALEZ. Study of the respiration of the chico. June, 1931.
34. MR. T. MERCADO, AND MR. P. JUACHON. A report on rice inbreeding in the College of Agriculture. September, 1931.
35. DR. N. B. MENDIOLA. Vegetative segregation in double Hibiscus and its inheritance. February, 1931.
36. DR. N. B. MENDIOLA. The Kawisari B coffee introduced into the College of Agriculture in 1927. March, 1931.
37. DR. N. B. MENDIOLA. Agronomical problems of the Iwahig Penal Colony. June, 1932.
38. DR. V. C. CALMA. Studies on the germination, vigor, and degree of tillering of top and cut-back seed-pieces of P.O.J. 2878 sugar cane. August, 1932.
39. MR. A. SAN PEDRO. Studies on the storage temperature requirements of lansones (*Lansium domesticum* Correa). September, 1932.
40. DR. LEON G. GONZALEZ. Artificial coloring of citrus fruits. November, 1932.

Department of Agricultural Chemistry

1. DR. F. O. SANTOS, AND MR. ESTEBAN G. COLLADO. Is an accessory food factor present in uray babae (*Amaranthus* sp.). July, 1924.
2. DR. F. O. SANTOS. Is Pirquet's Law applicable to Filipinos? January, 1925.
3. DR. F. O. SANTOS, AND MR. ESTEBAN G. COLLADO. The status of nutrition among students in the College of Agriculture. November, 1925.
4. DR. F. O. SANTOS, AND MR. ESTEBAN COLLADO. The nutritive value of sweet potato: I. The antineuritic properties of the leaves and shoots. March, 1927.
5. DR. F. O. SANTOS, AND MR. ESTEBAN G. COLLADO. The comparative water soluble vitamin content of sweet potatoes. February, 1928.
6. DR. F. O. SANTOS, AND MR. ESTEBAN G. COLLADO. The nutritive value of sweetened condensed milk (Milkmaid Brand). March, 1928.
7. DR. F. O. SANTOS. The Imperial Government Institute for Nutrition, Japan. July, 1928.

8. MR. F. A. SOLIVEN. The effect of tapping coconut palm for toddy on the production of copra and oil. January, 1929.

9. DR. F. O. SANTOS. The diet of beriberi families in Nueva Ecija and Cavite. February, 1929.

10. PROF. R. H. KING, AND MR. G. GUANZON. Color blindness among College of Agriculture students. March, 1929.

11. DR. V. C. LAVA. Chemical studies on coconut products. September, 1929.

12. PROF. R. H. KING. Base exchange and soil characteristics in relation to cane growth. October, 1929.

13. DR. F. O. SANTOS, AND MR. ESTEBAN G. COLLADO. The nutritive value of Philippine cereals: II. Gariñgan tapucoy. February, 1930.

14. MR. N. GALVEZ. The use of antimony electrode in the control of cane-juice defecation and the determination of the hydrogen ion on concentration of soils. June, 1930.

15. DR. F. O. SANTOS, AND MR. N. PIDLAOAN. Nutritive value of balut: I. Studies on calcium. February, 1931.

16. MR. ESTEBAN G. COLLADO. A study of the diet of the Filipino 1930 Olympic Team. March, 1931.

17. DR. F. T. ADRIANO, AND MR. J. BANZON. The relative efficiency of different chemical agents in bleaching buri fiber. August, 1931.

18. DR. F. T. ADRIANO. Edible Philippine mushrooms. September, 1931.

19. DR. F. T. ADRIANO. An improved device for adding the saturated alkali solution in the Kjeldahl method for nitrogen determination. October, 1931.

20. MR. N. L. GALVEZ. The amino-acid content of kandule (*Arius* spp.) November, 1931.

21. MR. FLORENCIO A. SOLIVEN. An investigation on the use of phosphoric acid for inversion in sugar analysis. January, 1932.

22. DR. F. T. ADRIANO, AND MR. J. BANZON. The preparation and composition of Philippine vinegars. February, 1932.

23. MR. LEOPOLDO T. VILLANUEVA. Modified ammonia bulb for total nitrogen determination by the Kjeldhal method. March, 1932.

24. MESSRS. H. E. LUMANG, AND L. J. VILLANUEVA. The effect of cane molasses on the nitrate content of a clay loam soil kept under varying conditions of moisture. June, 1932.

25. DR. F. O. SANTOS, AND MR. N. A. PIDLAOAN. The food of the male inmates of Bilibid Prison. February, 1933.

26. MR. R. A. CRUZ, AND MR. R. T. MARFORI. Chemical analysis of the water supply in the College of Agriculture. March, 1933.

27. DR. A. I. DE LEON, AND MR. R. REYES. Destructive distillation of some agricultural waste products. June, 1933.

28. DR. F. O. SANTOS, AND MR. N. A. PIDLAOAN. The food of the inmates of the Correctional Institution for Women. September, 1933.

Department of Agricultural Engineering

1. Prof. A. L. Teodoro. Important features of the commoner types of native Philippine plows. February, 1925.
2. Prof. A. L. Teodoro. Drafts of walking plows. June, 1925.
3. Dr. A. L. Teodoro. The effect of compression ratio on the suitability of alcohol as a fuel for tractor engines. January, 1930.
4. Mr. A. B. Catambay. Efficiency of different plows. February, 1930.
5. Prof. A. B. Catambay. Cost of harvesting cassava with the use of machinery. January, 1932.
6. Mr. Santiago R. Cruz, and Mr. Ignacio R. Ang. Gasanol, kerosene, alcohol, and gasoline as fuels for some makes of small gas engines. March, 1932.
7. Dr. A. L. Teodoro, and Mr. J. Banzon. On the performance of tractor engine using Gasanol, Gastarla, and mixtures of pure kerosene and crude oil as fuels. July, 1932.
8. Dr. A. L. Teodoro, Mr. S. R. Cruz, and Mr. E. M. Bautista. Characteristics of power consumption curves of some tractor engine fuels. December, 1932.
9. Dr. A. L. Teodoro, and Mr. J. P. Mamisao. Truck field tests in Calamba Sugar Estate using denatured alcohol, dehydrated alcohol and gasoline as fuels. June, 1933.

Department of Animal Husbandry

1. Dr. F. M. Fronda. Double-yolked eggs. December, 1923.
2. Dr. B. M. Gonzalez. Scientific method of selection of large farm animals. January, 1924.
3. Dr. B. M. Gonzalez, and Mr. F. P. Lago. Pigs for lechon. November, 1924.
4. Dr. B. M. Gonzalez. An informal account of a trip on a cattleship to Australia. January, 1925.
5. Dr. F. M. Fronda. Origin and development of the College strain of Cantonese. June, 1925.
6. Dr. V. Villegas. A study of the breeding efficiency of cows under range conditions. July, 1925.
7. Dr. B. M. Gonzalez. Weighing farm animals on a portable scale. October, 1925.
8. Dr. B. M. Gonzalez. Experience in the Philippines with the introduction of purebred animals to improve the common stock. August, 1926.
9. Dr. F. M. Fronda. Studies in the fertility of the hen's egg. September, 1926.
10. Dr. B. M. Gonzalez. Observations on the duration of service and serviceable life of work cattle. September, 1926.
11. Dr. M. Mondoñedo, and Mr. Paterno Bayan. A comparative study of corn and cassava as feeds for hogs. October, 1926.
12. Dr. Valente Villegas, and Mr. A. D. Pablo. A preliminary study on the dairy qualities of goats. October, 1926.

13. DR. B. M. GONZALEZ. Observations on education and research in Japan—agricultural and general (with lantern slide illustrations). December, 1926.

14. DR. F. M. FRONDA. A "short-cut" method for determining approximately profits and losses in a poultry project. January 1927.

15. DR. B. M. GONZALEZ, AND DR. VALENTE VILLEGAS. Experimental studies on the etiology of osteoporosis: I. The heritable nature of the disease. July, 1927.

16. DR. F. M. FRONDA, AND MR. PATERNO BAYAN. The dressing losses of poultry. August, 1927.

17. DR. M. MONDOÑEDO. A comparative study of corn and cassava as feeds for hogs: II. Ground corn vs. raw-chopped cassava. September, 1927.

18. DR. F. M. FRONDA. Accuracy in the weighing of experimental chickens. September, 1928.

19. DR. VALENTE VILLEGAS. The trend of sexual and reproductive seasons among horses, cattle, water buffaloes, sheep and goats under Los Baños conditions. A preliminary report. November, 1928.

20. MR. FELIX B. SARAO. The cost of milk production at the College of Agriculture. November, 1928.

21. DR. F. M. FRONDA, AND DR. B. M. GONZALEZ. The Nagoya, a new immigrant from Japan. January, 1929.

22. DR. VALENTE VILLEGAS. Determination of age of water buffaloes by the eruption of temporary and permanent incisors. June, 1929.

23. DR. M. MONDOÑEDO. The cost of producing pork at the College of Agriculture. July, 1929.

24. DR. M. MANRESA, DR. B. M. GONZALEZ, MR. FELIX B. SARAO, AND MR. JOSÉ P. ESGUERRA. Studies on the inheritance of coat colors and color patterns in crosses involving Philippine Native with Hereford and Nellore cattle. Preliminary report. January, 1930.

25. DR. F. M. FRONDA, AND MR. P. S. PAJE. Observations on the activities of fowls in the laying house. July, 1930.

26. DR. M. MANRESA, AND MESSRS. F. B. SARAO, C. TUASON, T. PEPITO, AND E. AGUDO. Age determination in ox reared under Philippine conditions. August, 1930.

27. DR. V. VILLEGAS, MISS M. MANAHAN, AND DR. F. T. ADRIANO. The amount and fertilizing constituents of fresh solid excreta voided by Philippine horses. January, 1931.

28. DR. M. MANRESA. Physiology of reproduction in the ox: Changes in the generative organs in open and pregnant heifers and cows. January, 1931.

29. DR. M. MONDOÑEDO, AND MR. FIDEL ALONTE. A comparative study of corn, cassava, sweet potatoes and poñgapong as feeds for swine. June, 1931.

30. DR. V. VILLEGAS, AND MR. A. T. TALEON. Observations on the activity of Philippine carabao in the barn. December, 1931.

31. DR. F. M. FRONDA. Comparative studies on the value of various mash mixtures for laying hens. January, 1932.

32. DR. B. M. GONZALEZ. Report on a trip to the Iwahig Penal Colony. June, 1932.

33. DR. F. M. FRONDA, AND MR. ACELO C. BADELLES. To what extent can actual head measurements be used in selection? July, 1932.

34. DR. F. M. FRONDA, AND MR. PASCUAL N. ANDRES. Effects on hatchability of holding eggs in a low temperature. October, 1932.

35. MR. A. T. TALEON, DR. V. VILLEGAS, AND MRS. M. MANAHAN-YLAGAN. The digestibility of flint corn silage by the carabao. December, 1932.

36. MR. ENGRACIO BASIO. A comparative study of the emasculator and the emasculatome methods of castration. January, 1933.

37. DR. F. M. FRONDA, MR. JUAN S. PADILLA, AND MR. ACELO C. BADELLES. Protein supplements in poultry rations: I. Comparative studies of the effects of shrimp meal, meat scraps, tankage, and fish meal as supplements in rations for growing chicks. August, 1933.

38. DR. M. MONDOÑEDO. The reproductive activity of the Berkjala sows as affected by seasons. September, 1933.

39. DR. F. M. FRONDA, MR. ALFREDO A. FRANCISCO, AND MR. G. S. CHAN. Protein supplements in poultry rations: II. Comparative effects of shrimp meal, meat scraps, tankage, and fish meal as supplements in rations for laying hens. October, 1933.

Department of Entomology

1. DEAN C. F. BAKER. Entomological work in the Philippines (with illustrations). February, 1924.

2. DR. L. B. UICHANCO. Notes on the embryonic development of the sugar cane bud moth (*Laspeyresia schistaceana* Sn.). October, 1924.

3. DR. L. B. UICHANCO. Biological notes on a braconid parasite, *Chelonus* sp. in relation to the rice army worm, *Spodoptera mauritia* Boisduval. September, 1925.

4. DR. L. B. UICHANCO. An interpretation of the phylogenetic significance of the feeding habits of certain mandibulate phytophagus insects. March, 1926.

5. DR. L. B. UICHANCO. Insects in relation to the introduced cultivated element of the Philippine flora. August, 1926.

6. DR. L. B. UICHANCO, AND PROF. M. B. RAYMUNDO. Determination of the cutting season of three species of structural bamboos in relation to their resistance to attack of bostrychids. October, 1927.

7. DR. L. B. UICHANCO. Biological notes on sugar cane white grubs, with special reference to field control. March, 1928.

8. DR. DEOGRACIAS VILLADOLID. The fisheries of Laguna de Bay with special reference to the problem of conservation and protection. August, 1928.

9. DR. L. B. UICHANCO. A cheap and apparently effective method of field control of sugar cane white grubs, *Leucopholis irrorata* Chevr. February, 1929.

10. MR. ANDRES M. MANE. The spawning habits of the kandule, *Arius* sp. in Laguna de Bay. June, 1929.

11. DR. DEOGRACIAS VILLADOLID. The destruction caused by some of the fishing gear to the kandule (*Arius* sp.) fishery in Laguna de Bay. July, 1929.
12. DR. L. B. UICHANCO. Certain phases of agricultural work in Java. August, 1929.
13. DR. L. B. UICHANCO, AND MR. C. T. BULIGAN. Experiments on the treatment of sugar cane points with insecticides and insect repellants. November, 1930.
14. MR. ANDRES M. MANE. The feeding and spawning habits of ayuñgin (*Mesopristes plumbea* Kner), a common theraponid of Laguna de Bay. February, 1932.
15. DR. L. B. UICHANCO, AND MR. S. R. CAPCO. Effect of various methods of storing corn on the degree of damage due to weevils. July, 1933.

Department of Plant Pathology

1. MR. E. F. ROLDAN. A new host of the organism causing solanaceous wilt. (*Bacterium solanacearum* E. F. Smith). January, 1924.
2. MR. E. F. ROLDAN. The soft rot of pineapple in the Philippines and in other countries. November, 1924.
3. DR. G. O. OCFEMIA, AND MR. E. F. ROLDAN. Phytophthora blight of citrus. December, 1924.
4. MR. JULIAN A. AGATI. The cause of anthracnose of mango and avocado in the Philippines (*Glomerella cingulata* Stonem.). January, 1925.
5. DR. G. O. OCFEMIA. Phytophthora disease of eggplant. July, 1925.
6. MR. MACARIO A. PALO. Rhizoctonia disease of rice. October, 1925.
7. MR. E. F. ROLDAN. Bacterial wilt of cosmos. December, 1925.
8. MR. J. A. AGATI. Anthracnose of guava. January, 1926.
9. DR. G. O. OCFEMIA. The bunchy top of abacá. January, 1927.
10. MR. MACARIO A. PALO. A fusarium bulb rot of onions—a progress report. January, 1928.
11. MR. E. F. ROLDAN. A bacterial stem rot of hybrid cane seedlings. March, 1930.
12. MR. M. S. CELINO. A fungus disease of coconut leaf miner (*Promecotheca cumingii* Baly). July, 1930.
13. MR. E. F. ROLDAN. Pokkah-boeng, a disease of sugar cane newly imported into the Philippine Islands with the Javanese cane P.O.J. 2878. October, 1930.
14. DR. G. O. OCFEMIA. The relation to the heart rot of abacá of the *Fusarium* associated with field cases of the disease. March, 1931.
15. MISS VICTORIA B. MENDIOLA. Downy mildew of soybeans. September, 1932.
16. DR. G. O. OCFEMIA, AND MR. MARTIN S. CELINO. A brown bark rot of cacao trunk. October, 1932.
17. DR. G. O. OCFEMIA. An evidence relating to the transmissibility of the Fiji disease of sugar by an insect vector. February, 1933.
18. MR. M. S. CELINO. Blight of cinchona seedlings. August, 1933.

Department of Plant Physiology

1. PROF. D. A. HERBERT. Stinging crystals in plants. December, 1923.
2. DR. EDUARDO QUISUMBING. Philippine weeds. January, 1924.
3. DR. EDUARDO QUISUMBING. On the continuity of protoplasm in the endosperm cells of *Diospyros*. October, 1924.
4. DR. JOSÉ B. JULIANO. On the origin, development and nature of the stony layer of the coconut. December, 1924.
5. DR. R. B. ESPINO. Further studies on the salt requirements of young rice plants. August, 1925.
6. DR. E. QUISUMBING. Recent studies on abacá in the Bicol region. August, 1925.
7. DR. E. QUISUMBING. Anatomical studies of Para rubber, *Hevea brasiliensis* (HBK) Muell.—Arg. November, 1925.
8. MR. FERNANDO DE PERALTA. Growth and development of young rice plants grown in complete culture solution to which NaCl was added. July, 1926.
9. DR. R. B. ESPINO, AND MR. R. P. ESTIOKO. Critical study of the nutritive value of nitrate nitrogen for young rice plants. November, 1927.
10. DR. R. B. ESPINO. Growth and development of young rice plants as influenced by the food in the seed. January, 1928.
11. DR. R. B. ESPINO. Agricultural problems in the island, "Hermano Mayor". June, 1928.
12. DR. R. B. ESPINO, AND MR. F. T. PANTALEON. Influence of light upon growth and development of certain plants. November, 1930.
13. MR. FERNANDO DE PERALTA. Effects on the yield of grain and straw of rice by allowing weeds to decay in soil. July, 1931.
14. DR. R. B. ESPINO, AND MR. F. T. PANTALEON. Harmful effects of rice straw when added to soil in pots upon young rice and maize plants. July, 1933.

Department of Rural Economics

1. MR. PABLO N. MABBUN. Studies on tobacco cooperative marketing in the Cagayan Valley. September, 1927.

Department of Soils

1. DR. R. L. PENDLETON. Soil surveys in Negros and Mindoro. December, 1925.
2. DR. R. L. PENDLETON. Some observations on agricultural research in Japan. July, 1928.
3. DR. R. L. PENDLETON. Some observations from travels in Java. August, 1929.
4. DR. DIONISIO I. AQUINO. A non-symbiotic nitrogen-fixing organism of the genus *Azotobacter* in some Philippine soils. June, 1931.
5. PROF. I. ELAYDA. Agricultural survey of the Iwahig Penal Colony. September, 1931.

Medical

1. DRS. M. A. TUBANGUI, AND S. A. FRANCISCO. On the nature, distribution and significance of the hookworm infestation in the Philippines. January, 1926.
2. DRS. M. A. TUBANGUI, AND S. A. FRANCISCO. The presence in human feces of the ova of fish trematodes. October, 1929.
3. DR. C. MANALANG. Notes on malaria cases and deaths. January, 1931.
4. DR. MANUEL QUIZUMBING. Uno caso de vagina imperforada en una mujer puber. Marzo, 1931.
5. DR. RICARDO A. RAYMUNDO. Enfisema general de origen traumatico. Marzo, 1931.
6. DRS. SIXTO A. FRANCISCO, ANICETO V. ASCALON, AND RICARDO A. RAYMUNDO. Lithopaedion. (report of a recent case). March, 1931.
7. DR. C. AFRICA. Experimental creeping eruption and its probable presence in the Philippines. September, 1931.

School of Forestry

1. MR. PLACIDO DACANAY. Behavior of malaruhat under a dense stand of ipilipil. December, 1923.
2. PROF. A. P. RACELIS. A method of calculating the number of trees for measurement in the Bureau of Forestry Rubber Plantation. January, 1930.
3. FORESTER CARLOS SULIT. Increased diameter growth of bagtikan (*Parashorea malaanonan* Merr.) after release from seed, nurse or wolf trees. August, 1930.
4. RANGER M. D. SULIT. Some tree-destroyers belonging to the Mistletoe family. September, 1930.
5. FORESTER A. DE MESA. Notes on some bark beetles and wood borers damaging timber in the Philippines. October, 1930.
6. RANGER MAMERTO D. SULIT. Native methods of preparing namí (*Dioscorea hispida* Dennst.) tuber for food. July, 1931.
7. MR. PORFIRIO SAN BUENAVENTURA. Propagation of narra (*Pterocarpus indicus* Willd.) by cuttings. October, 1931.
8. FORESTER LUIS J. REYES. "Gumaan" driftwood (*Cavanillesia*). November, 1931.
9. RANGER GIL ALTAMIRANO. Cinchona cultivation in the Philippines. August, 1932.
10. RANGER RICARDO BUHAY. Chemical control of sap-stain and mold in green lumber and logs. January, 1933.
11. RANGER NICANOR P. LALOG. Studies on the comparative effects of the duration of direct sunlight in the establishment of plantation of camagon (*Diospyros discolor* Willd.). February, 1933.
12. RANGER MAMERTO D. SULIT. Collection and care of Philippine orchids. March, 1933.

13. MR. JUSTINO SEGUERRA. A proposed method of determining the area of a circular segment. Its application in the computation of the volume of slabs from cylindrical logs. August. 1933.
14. MR. CALIXTO MABESA. Shrinkage in Philippine woods. August, 1933.
15. FORESTER LUIS J. REYES. Common Philippine bamboos. Their structure and identification. October, 1933.

College of Veterinary Science

1. DR. M. A. TUBANGUI. Two larval parasites from the musang (*Paradoxurus philippinensis*. December, 1923.
2. DR. C. H. SCHULTZ. A reliable source of heat for laboratory purposes (with a demonstration). January, 1924.
3. DR. MIGUEL MANRESA. Impaction of the crop caused by candles. February, 1924.
4. DR. A. K. GOMEZ. A case of rabies on the College Campus. February, 1924.
5. DR. G. SAN AGUSTIN. Maceration and bleaching of bones for anatomical specimens. July, 1924.
6. DRS. G. SAN AGUSTIN, M. MUÑOZ, AND M. M. ROBLES. Observations on the intraperitoneal injections of blood in dogs. Preliminary report. June, 1925.
7. DR. C. H. SCHULTZ. Clinical observations on epizootic lymphangitis. July, 1925.
8. DR. A. K. GOMEZ. An outbreak of fowl cholera in Los Baños. August, 1925.
9. DR. M. A. TUBANGUI. The economic significance of some parasitic diseases prevalent in the Philippines. September, 1925.
10. DR. M. A. TUBANGUI. Worm parasites of Philippine chickens: Their treatment and control. March, 1926.
11. DR. A. K. GOMEZ. The intensity and distribution of infectious diseases of animals in the Philippines. October, 1925.
12. DR. MANUEL ROBLES. A résumé of the causes, classes and occurrences of accidental wounds among domesticated animals. July, 1926.
13. DR. MARCOS TUBANGUI. Laboratory studies on surra with especial reference to the nature of the immunity following the cure of experimental infections. August, 1926.
14. DR. ZACARIAS DE JESUS. Cysticercosis in the native swine. September, 1926.
15. DR. G. SAN AGUSTIN. Meat inspection work in relation to public health in the Philippines. October, 1926.
16. DRS. A. K. GOMEZ, AND Z. DE JESUS. The production of biological products in the College of Veterinary Science. March, 1927.
17. DR. M. A. TUBANGUI. Notes on larval trematodes from Philippine snails. July, 1927.
18. DR. Z. DE JESUS. The germicidal properties of the mixture of kerosene and coconut oil. October, 1927.
19. DR. LOPE, M. YUTUC. An unusual case of ventral hernia in a Philippine dog. January, 1928.

20. Dr. A. K. Gomez. An infectious disease of chickens. February, 1928.
21. Dean G. San Agustin. Observations in Bukidnon. June, 1928.
22. Dr. A. K. Gomez. Is the carabao susceptible to tuberculosis? August, 1928.
23. Drs. M. A. Tubangui, and R. Q. Javier. Studies on the factors influencing the distribution of hookworm infestations in the Philippines. September, 1928.
24. Dr. M. A. Tubangui. Studies on the development of *Cercaria dorsocauda*. December, 1928.
25. Drs. A. K. Gomez, and A. Gonzaga. A carcinoma in a Cantonese hen. February, 1929.
26. Dr. Ramon Q. Javier. Determination of Filipino ponies' red and white blood corpuscles and hemoglobin. Preliminary report. November, 1929.
27. Dr. A. C. Gonzaga. Normal temperature and pulse and respiration ratio of Philippine horses. February, 1930.
28. Dr. Zacarias de Jesus. Bacteriological analysis of the water supply of Los Baños Colleges with special reference to its potability. March, 1930.
29. Drs. A. K. Gomez, and Z. de Jesus. Epizootic lymphangitis and glanders among Filipino ponies with special reference to the occurrence of mixed infection. June, 1930.
30. Dr. A. K. Gomez. Some observations on the sources of tuberculosis infection. March, 1931.
31. Dr. Tomas T. David. Relation of leucocytes to lactation. July, 1931.
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EFFECTS OF PRE-HEATING ON THE OPERATION OF A HIGH COMPRESSION TRACTOR ENGINE USING ALCOHOL AND ALCOHOL-GASOLINE BLENDS AS FUELS [1]

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WITH TWO TEXT FIGURES AND SIX CHARTS

The carburetion system of most of the tractors on the market at present is provided with a pre-heating device so as to attain efficient operation on kerosene. Some pre-heaters are designed to give constant heat input while others have regulators to vary the heat energy supplied. Exhaust gases are the principal sources of heat supply. In this study, the writer presents the effects of using one of these devices on the operation of a tractor engine when alcohol and gasoline-alcohol blends were used as fuels.

In countries where, in tractor engines, some kinds of alcohol fuels are used as a substitute for kerosene, operators must have noted the beneficial or the bad effects of pre-heating on the particular kind of motor alcohol used. No published data on this subject, particularly with regard to the operation of multicylinder engines, are, however, available at this writing. The investigation reported in this paper was carried out not with the idea of giving the definite amount of heat energy necessary to pre-heat efficiently certain particular kinds of motor alcohol or gasoline-alcohol blend, but, to measure the effects of a pre-heating device on the power, fuel consumption and operation of the engine used.

Extensive experiments were conducted in the testing laboratory of the Agricultural Engineering Department of the College of Agriculture, University of the Philippines for over six months in 1932 with the following objects:

1. Without making any alteration on the carburetor of the engine used, what are the effects of varying the degree of pre-heating on the power, fuel consumption and operation of the said engine using different kinds of motor alcohol fuels?

[1] College of Agriculture Experiment Station contribution No. 939. Received for publication November 25, 1933.

2. What changes are recorded when alterations on the carburetor are made?

3. What are the effects noted with higher compression ratios?

MATERIALS AND METHODS

Engine. The engine used was a McCormick-Deering four cylinder Power Unit, Model 300. It has a bore of 4¾", stroke 6", engine speed of 1050 r.p.m., pulley speed of 1050 r.p.m., belt speed of 3300 ft.p.m., pulley diameter of 12", pulley face of 9½" (lagged), and a fuel tank of 19 gallons capacity. The engine was provided with a 14" single plate, dry disk clutch, a 1½" "RW" kerosene carburetor with water attachment, an E4A magneto with International

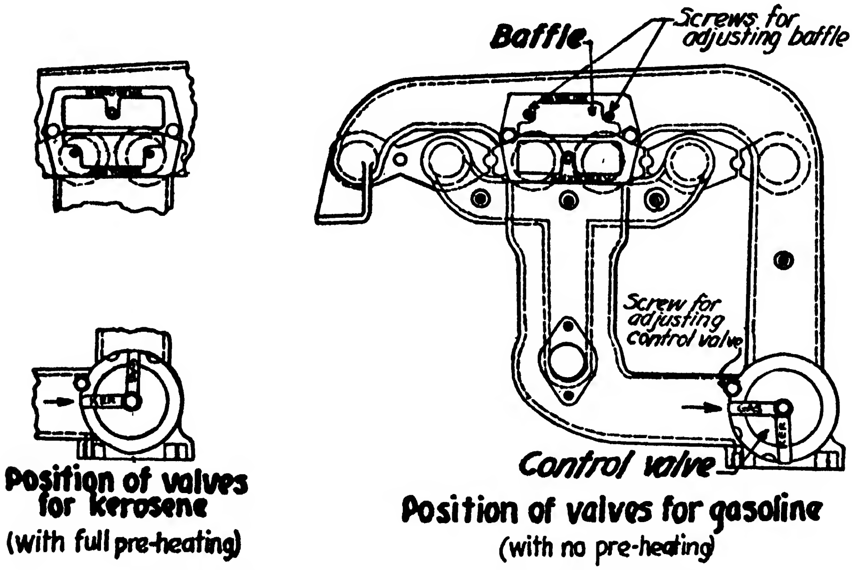

Fig. 1.—Schematic layout of the pre-heating device.

Automatic impulse coupling, a thermostatic controlled water system, an air filter (Oil-International), a governor (constant speed), and an oil pressure gauge. When tested, the engine was completely equipped with all its accessories. It was belted to a Froude hydraulic dynamometer to measure the delivered horsepower.

Three sets of pistons were used to vary the compression ratio. The ratios were computed to be 4.42:1, 5.22:1, and 5.92:1. The engine and all its accessories were lent to the College of Agriculture, University of the Philippines by the International Harvester Company of Philippines.

Pre-heating device. The carburetor and manifold were originally designed for good performance with either gasoline or kerosene. Two valves were provided to control the exit of the exhaust gases. One valve called the baffle can be made to deflect the gases through the intake portion of the manifold when operated on kerosene. When in gasoline position, the gases can be deflected away from this portion. (See fig. 1.) Another valve, called the control valve, can be turned around in such a way as to block off the passage of hot gases one way when set in gasoline position and in another way when in kerosene position.

Pre-heating was classified as full, medium and none. When operating on full, the baffle and control valves were set on kerosene position. For medium pre-heating, the baffle was kept on kerosene position, but the control valve was set on the notch one-half way between gasoline and kerosene positions. For "none" pre-heating, the valves were set on gasoline position.

Fuels. The fuels used were Gasanol, Gastarla, Samson motor fuel, Kabankalan motor alcohol, La Tondeña special motor alcohol, and Gasco. Their approximate compositions are as follows:

Gasanol

Alcohol 95½ per cent by volume	50 parts
Commercial gasoline	45 "
Sulfuric ether s. g. 0.730	5 "
	100 parts

Gastarla

Alcohol, 96 per cent	60 per cent
Gasoline	35 " "
Benzol	5 " "
	100 per cent

Samson motor alcohol

Composition not given.

Kabankalan motor fuel

Composition not given.

La Tondeña special denatured alcohol

Alcohol	97.5 per cent
Gasoline	2.0 " "
Aniline oil	0.5 " "
	100.0 per cent

Gasco

Ethyl alcohol, 95 per cent	100 parts
Sulfuric ether	10 "
Methyl alcohol, 95 per cent	2 "

The fuels given below were provided gratis by the following sugar centrals:

Gastarla by Central Azucarera de Tarlac
Kabankalan motor fuel by Kabankalan Sugar Co., Inc.

Lubricating oil. The Asiatic Petroleum Company provided, without charge, Triple Shell oil for the crank case.

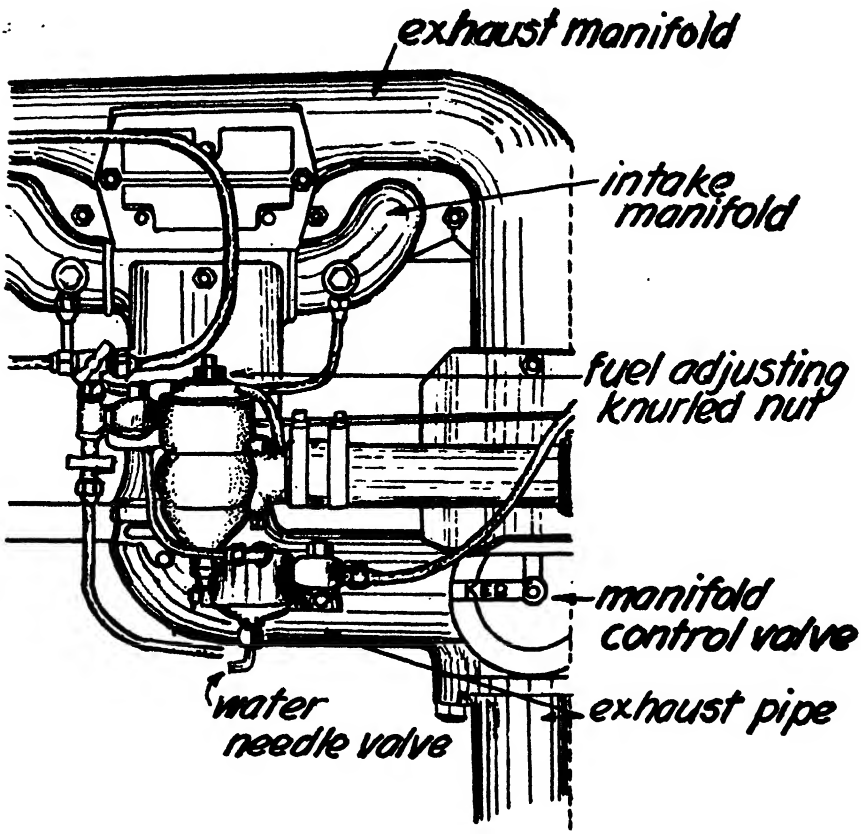

Fig. 2.—Showing a portion of the engine with the pre-heating device.

Testing appliances. The testing appliances used in this investigation were the same as those used by the writer in his studies on the adaptability of Gasanol, Gastarla, kerosene, and mixtures of kerosene and crude oil as fuels for the same kind of engine.[2] Prac-

[2] TEODORO, A. L., AND J. BANZON. 1932. Tractor engine test using Gasanol, Gastarla, pure kerosene, and mixtures of pure kerosene and crude oil as fuels. The Philippine Agriculturist 21: 370–413. *Fig. 1–3; charts 1–5.*

tically, the same procedures were followed in overhauling the engine and in adjusting the dynamometer.

Experimental. Several series of tests were carried on as follows:

Gasanol. Three series of tests were run with and without pre-heating. The carburetor for each series of tests was adjusted to give approximately the rated power of the engine without any pre-heating. The same opening was used for the experiments with pre-heating. There was no attempt to develop more power than the rated capacity. The normal jet for gasoline and for kerosene was used in all tests.

Gastarla. Three series of tests were run using three different compression ratios, with and without pre-heating. The choke was wide open in all tests. The normal jet for gasoline and for kerosene was used in all of the tests.

Samson motor fuel. It was the general plan in the series of tests using Samson motor fuel to determine the direct effects of pre-heating at three different compression ratios. No attempt was made to enlarge the fuel jet. A number of short tests were carried out to record the variations in fuel consumption when the choke was slightly closed. The carburetor was adjusted to give the optimum consumption at the required maximum power for each series of tests.

Kabankalan motor fuel. Eight groups of tests were carried out using compression ratio 4.42:1. With no pre-heating, tests were run to determine the effects on the power developed and on the fuel consumed of using a single jet and of using enlarged jets. The effect of partially closing the choke valve to gain power was also determined. With higher compression ratios and with the choke wide open, comparative tests were made for without, for medium, and for full pre-heating. The normal jet for gasoline and kerosene was used in the high compression experiments.

La Tondeña special alcohol. The engine was run in all tests without changing the size of the original carburetor jet. With compression ratio best suited for gasoline and kerosene, tests were carried on to find the effects of no pre-heating and of medium and full pre-heating for both wide open and partially closed choke valve. The choke was partially closed with the compression ratio of 4.42:1 in order to make the engine develop the rated capacity. With higher compression ratios, runs were made with only wide open choke. The effects of pre-heating and without pre-heating were determined. Extra tests were made with compression ratio 5.22:1 to study the difference in fuel economy between carburetor setting best suited

for no pre-heating and the setting found most economical with pre-heating.

Gasco (denatured alcohol). A number of trial tests were run to find the maximum horsepower that the engine could develop with the normal jet (jet best adapted for gasoline or kerosene) with and

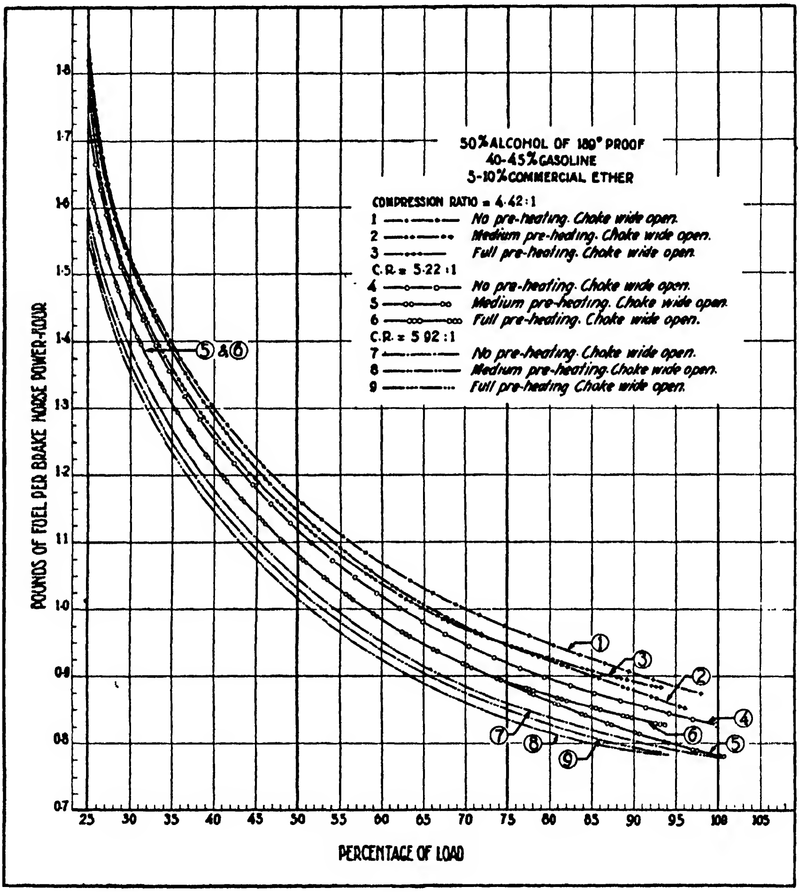

Chart 1.—Showing results of test using Gasanol.

without pre-heating at normal compression ratio and with wide open choke. Additional trial tests were made with slightly choked carburetor to measure the difference in fuel consumption between partially choked and wide open air throttles. After these preliminary runs, the effects of pre-heatings were determined using double fuel jets for compression ratio 4.42:1 and only the normal jet opening

for the higher ratios. The choke was kept wide open in all the regular tests and the carburetor openings were adjusted to give the optimum consumption at the maximum power developed.

RESULTS AND CONCLUSIONS [3]

Gasanol

The results of test using Gasanol are shown in table 1 and in chart 1.

Compression ratio 4.42:1. Short tests showed that with the compression ratio of 4.42:1, the engine was able to develop more than 40 horsepower. It was found, however, that there was not a convenient opening of the needle valve that would give exactly the rated power of the engine. The maximum horsepower which was taken as the full load capacity was only about 98.3 per cent of the rated power. The following results were observed:

1. A decrease of about 2 per cent in the horsepower developed was noted when medium pre-heating was used and about twice that amount when full pre-heating was applied. The consumption was most economical with medium pre-heating at or near the rated load. From one-fourth load to three-fourths load the most economical fuel consumption was shown with full pre-heating.

Compression ratio 5.22:1. A decrease in power of about 6 per cent was developed when full pre-heating was applied. With medium pre-heating, however, the power increased by 1 per cent over that without any pre-heating. The consumption at the highest load was most economical with medium pre-heating. From one-fourth to three-fourths load with full pre-heating it was definitely shown that the consumption was less than without any pre-heating.

Compression ratio 5.92:1. With the compression ratio of 5.92:1 the maximum power developed with medium pre-heating dropped by about 5 per cent. With full pre-heating the decrease was more than 7 per cent. From one-fourth load to about three-fourths load medium pre-heating showed the most economical fuel consumption. Full pre-heating showed a more economical fuel consumption than without any pre-heating at these same points.

The series of tests point to the following conclusions:

1. The carburetor opening that was found to give the rated power of the engine with the lowest compression ratio using no pre-heating was found to be too large to give the same power when the

[3] All the graphs were prepared in final form by Mr. J. P. Mamisao.

engine was run with higher compression ratio. Much smaller openings were used at higher compression ratio.

2. The engine could easily develop 40 horsepower with increased compression ratio.

3. Medium pre-heating indicated the best arrangement to give the most economical fuel consumption.

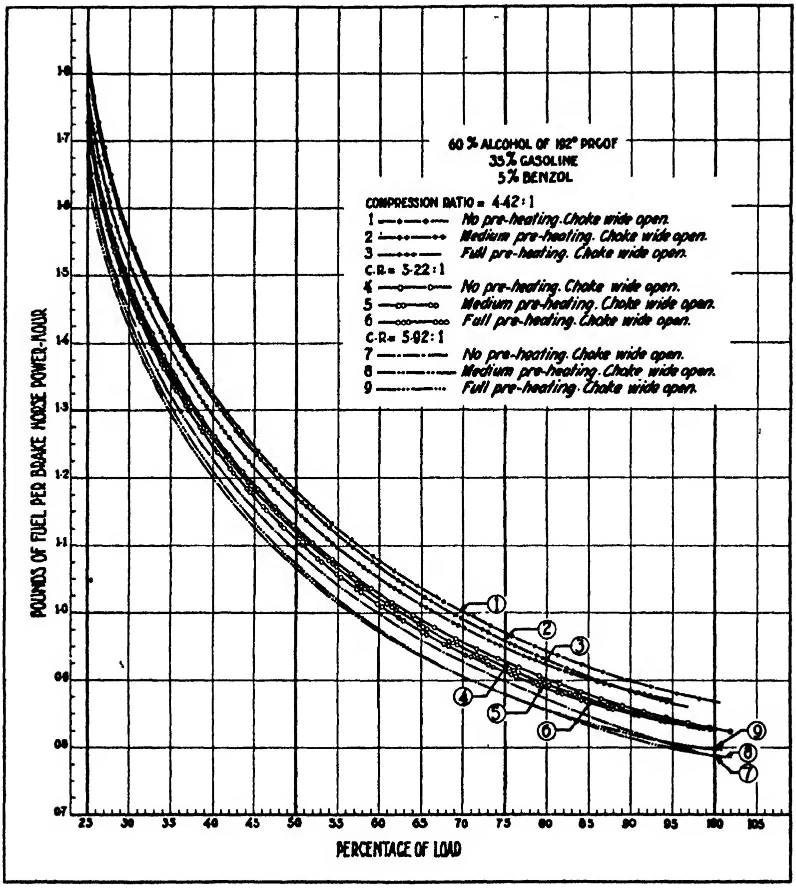

Chart 2.—Showing results of test using Gastarla.

4. The power of the engine decreased from 2 to 6 per cent when pre-heating was applied.

5. Full pre-heating with higher compression ratio was characterized by jerky operation, especially near the highest load.

6. With full pre-heating, the power of the engine could not be maintained constant after 30 minutes of operation.

Gastarla

The results of the test using Gastarla are shown in table 2 and in chart 2.

Compression ratio 4.42:1. It was definitely shown that without enlarging the jet and with the needle valve set to develop the rated power without pre-heating it was not possible to reach the rated point when pre-heating was carried on. The power decreased by about 3 per cent with medium pre-heating and by about 5 per cent with full pre-heating. The most economical consumption was obtained with medium pre-heating. The consumption with full pre-heating was higher than without any pre-heating at 95 per cent of the load. From one-fourth load to three-fourths load there was a decrease of about 3 per cent in fuel consumption.

Compression ratio 5.22:1. The results of the test point to the following:

1. There was a decrease of about 2 per cent in the maximum power developed as the engine was run with medium pre-heating and an additional 2 per cent when run with full pre-heating.

2. The consumption was most economical with medium pre-heating, especially from one-fourth to three-fourths load.

3. With full pre-heatings the decrease in consumption compared with that without pre-heating was hardly over 2 per cent.

Compression ratio 5.92:1. With the compression ratio of 5.92:1 the rated power was easily developed. A study of curves 7, 8, and 9 points to the following results:

1. The fuel consumption with medium pre-heating was the most economical. The decrease was about 2 per cent compared with the test without any pre-heating.

2. With full pre-heating the consumption at full load was higher by about 1 per cent than without any pre-heating. From one-fourth to three-fourths load, however, the consumption was about 2 per cent less.

The results of all tests using Gastarla motor alcohol showed the following:

1. With the carburetor set to give the rated power without pre-heating at the lowest compression ratio, it was easily possible to develop more power with higher compression ratio. Short tests proved that as high as 8 per cent above that of the rated capacity could be produced without reducing the number of turns best suited for low compression operation.

2. Decrease of power from 2 to 5 per cent was found when pre-heating was applied.

3. The most economical point occurred when medium pre-heating was used. With full pre-heating the consumption was generally higher at full load but was lower from one-fourth to three-fourths load than without any pre-heating.

4. Full pre-heating very often caused the engine to run unsteadily and to decrease the power after a few minutes of operation.

Samson motor fuel

The results of test using Samson motor fuel are shown in table 3 and in chart 3.

Compression ratio 4.42:1. The maximum power developed, using the normal fuel jet and with the choke wide open, was from 82.8 per cent of the rated capacity with full pre-heating to almost 90 per cent without pre-heating. It was very evident that the power decreased as the degree of pre-heating was increased. By slightly choking the carburetor, it was easily possible to raise the power to the rated point with and without pre-heating.

The most economical curve from near half-load to the maximum power was obtained with medium pre-heating and from near half-load to idling with full pre-heating. Partly choking the carburetor increased the fuel consumption from about 35 per cent at 90 per cent of the load to about 52 per cent at one-fourth load with medium pre-heating. Improper carburetor settings under different degrees of pre-heating revealed that fuel consumption could easily be doubled without causing the exhaust gases to appear dark.

Compression ratio 5.22:1 All the tests with compression ratio 5.22:1 point to the following results:

1. The higher the degree of pre-heating the less was the maximum power developed when the engine was operated on wide open choke.

2. The decrease in consumption with medium pre-heating over that without pre-heating was from about 1½ per cent at 90 per cent of the load to about 5½ per cent at one-fourth load. With full pre-heating the corresponding decrease was from 3 per cent to about 7 per cent.

3. Unnecessary increase in fuel consumption was secured by slightly choking the carburetor and by improper valve setting.

Compression ratio 5.92:1. With the fuel needle valve set to give the optimum consumption at the rated load without pre-heating, it was not possible to maintain very steady operations when pre-

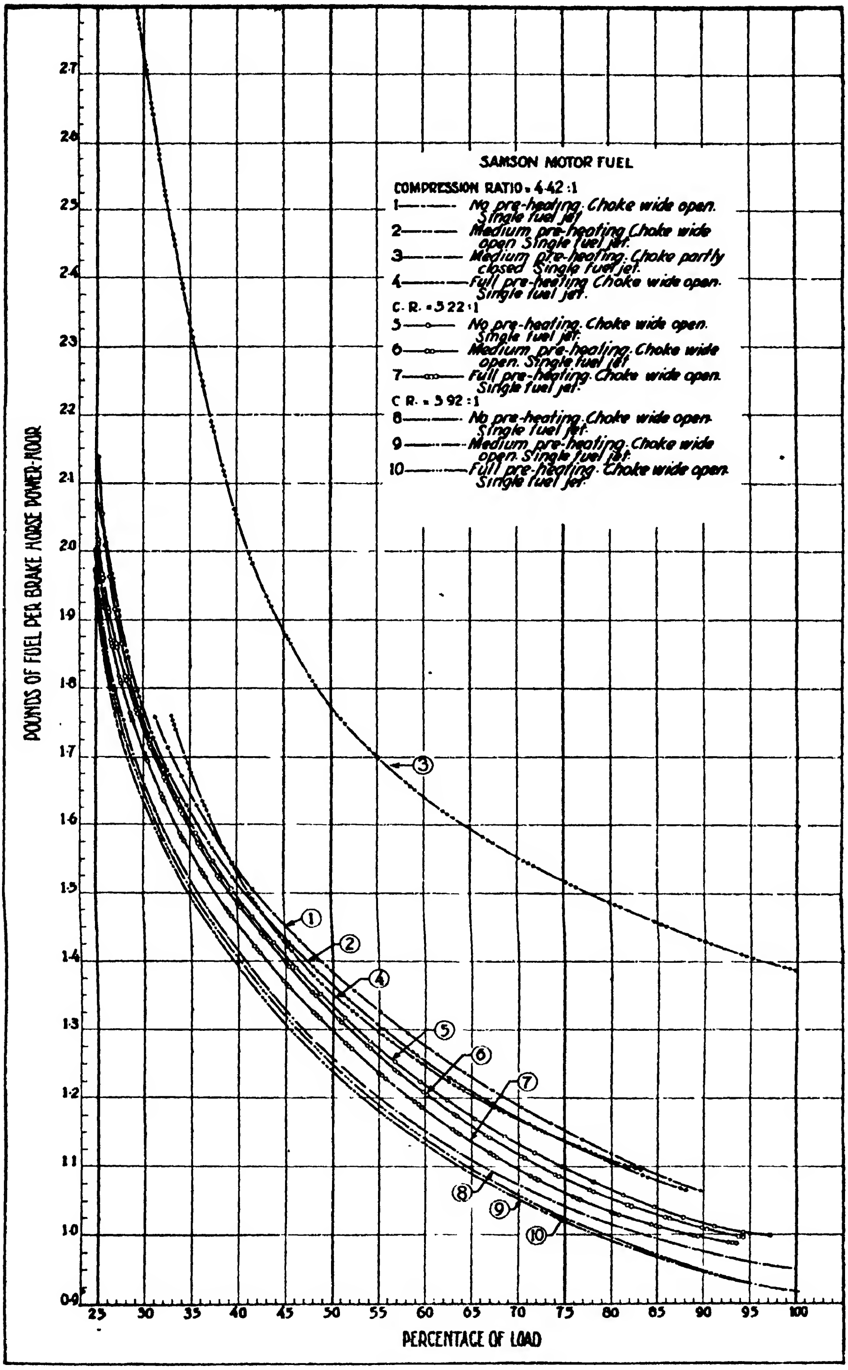

Chart 3.—Showing results of test using Samson motor fuel.

heatings were used. Two additional notches were added with the pre-heating tests to obtain very satisfactory operations at lighter loads.

The tests definitely showed that the consumption decreased by about 3 per cent with medium pre-heating and from 1 to 3 per cent with full pre-heating. There was indication that with full pre-heating the engine could not maintain constant running for a long period.

From the results of tests using Samson fuel the following conclusions can be definitely made:

1. The maximum power that could be developed was higher with no pre-heating than with pre-heating. The larger the compression ratio the higher the maximum power. It was not possible to reach the rated point with wide open choke even at compression ratio 5.22:1.

2. Slightly choking the valve increased the power more than the rated capacity, but at the expense of too much fuel.

3. The fuel consumption with full pre-heating appeared to be the most economical up to and including compression ratio 5.22.1. At compression ratio 5.92:1, medium pre-heating gave a more economical result than full pre-heating.

4. All other things being equal, the higher the compression ratio, the less was the fuel consumption per brake horsepower hour.

Kabankalan motor fuel

The results of test using Kabankalan motor fuel are shown in table 4 and in chart 4.

Compression ratio 4.42:1. The results of tests without pre-heating definitely point to the following:

1. With the Kabankalan fuel, it was possible to develop a maximum power of only about 80 per cent of the normal capacity when the engine was run on wide open choke and with single jet. With double jet, however, or by enlarging the fuel passage area, the rated power of the engine was easily produced. The same result was attained by slightly choking the carburetor using a single fuel jet. (See curves 1, 2, and 3.)

2. An economy of from 44 per cent near the full load to about 17.5 per cent near one-fourth load was made in favor of using double fuel jet without choking over that of single jet with slight choking.

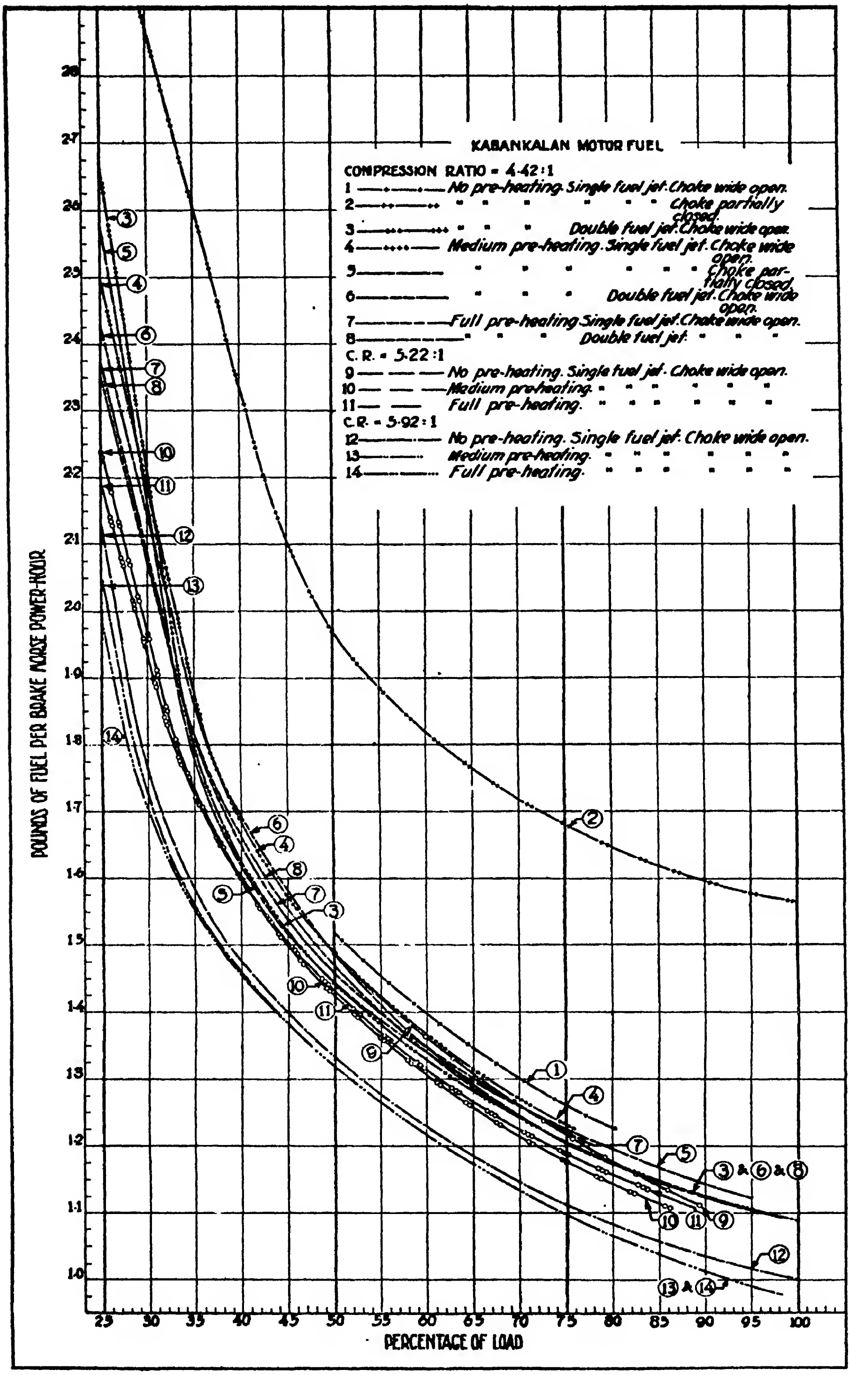

Chart 4.—Showing results of test using Kabankalan motor fuel.

Tests with medium pre-heating again showed that by slightly choking the carburetor the power was increased to the rated point. A maximum of only about 76.2 per cent was reached with wide open choke. A study of curves 5 and 6 shows that, except near the one-fourth load, medium pre-heating had no advantage over the best curve that could be obtained with no pre-heating.

Full pre-heating showed very definite decrease of fuel consumption only from no load to about one-fourth load. There was no evidence of better fuel economy beyond this point. The operation of the engine was not always steady.

The most economical curve with compression ratio 4.42:1 was obtained when the engine was not pre-heated and when the fuel jet was enlarged. Pre-heatings caused the engine to run unsteadily and to develop only about three-fourths of the rated capacity.

Compression ratio 5.22:1. A number of short trial tests showed that slightly choking the carburetor had an immediate effect of increasing the power developed with very poor fuel economy.

A study of curves 9, 10, and 11 points to the following results:

1. The maximum power developed without enlarging the fuel jet and with wide open choke was less than the required capacity, being 89.5 per cent of the rated load with no pre-heating, 85.3 per cent with medium pre-heating, and 83.7 per cent with full pre-heating.

2. The higher the degree of pre-heating the less was the fuel consumption per brake horsepower hour at lighter loads.

3. There was an indication that medium pre-heating had the most economical curve.

Compression ratio 5.92:1. The maximum horsepower that could be developed and maintained constant with the normal jet at this compression ratio was nearly at the rated capacity. Short tests revealed that the loads gradually decreased from the rated point to the maximum power recorded in these tests when pre-heating was applied. The higher the degree of pre-heating the greater was the decrease in power.

Economy in fuel consumption was very evident at lighter loads with pre-heatings. The decrease in fuel consumption with medium pre-heating compared with that of no pre-heating was about 4 per cent. From one-half load to near the full load, there was practically no marked difference in fuel economy between medium and full pre-heatings.

The results of all tests using Kabankalan motor alcohol as a fuel point to the following conclusions:

1. With a fuel jet area the same as the one adapted for gasoline or kerosene, it was impossible to develop the maximum brake horsepower of the engine when operated with wide open choke. Only from 75 to 80 per cent of the rated power was reached at compression ratio 4.42:1 and from 83 to 89 per cent at compression ratio 5.22:1. At compression ratio 5.92:1, the engine maintained constant operation near the full load.

2. Slightly choking the carburetor caused the engine to develop more power at the expense of too much fuel.

3. Medium pre-heating definitely showed economy of fuel compared with no pre-heating. It was indicated that there was very little difference in fuel consumption between medium and full pre-heating. Near the lighter loads, full pre-heating showed more economical consumption than medium pre-heating.

4. The higher the compression ratio the greater was the power developed and the less was the fuel consumption per brake horsepower hour.

La Tondeña special alcohol

The results of the test using La Tondeña special alcohol are shown in table 5 and in chart 5.

Compression ratio 4.22:1. The engine was not able to develop its rated capacity when it was run with wide open choke. It was found definitely that without enlarging the fuel jet the highest power developed was nearly 20 per cent less than its rated capacity. The maximum points recorded were only 68 per cent of the rated power with no pre-heating, 81.7 per cent with medium pre-heating, and 74.9 per cent with full pre-heating. The carburetor opening was adjusted to give the most economical fuel consumption when these points were recorded. The opening that gave the least fuel consumption when no pre-heater was used proved also to be the most economical when the pre-heater was tried for both medium and full arrangements. Any attempt to enlarge this opening resulted in unnecessary increase in fuel consumption without any evident increase in power developed.

It was further observed that by operating the engine with the choke wide open, an economy in fuel consumption was realized with pre-heating. With medium pre-heating the decrease in the amount of fuel used was approximately 10 per cent less than without any pre-heating. With full pre-heating, an additional economy of 4 per cent was recorded from no load point to a point where the curve nearly terminates. This curve (curve 5) which very gradually

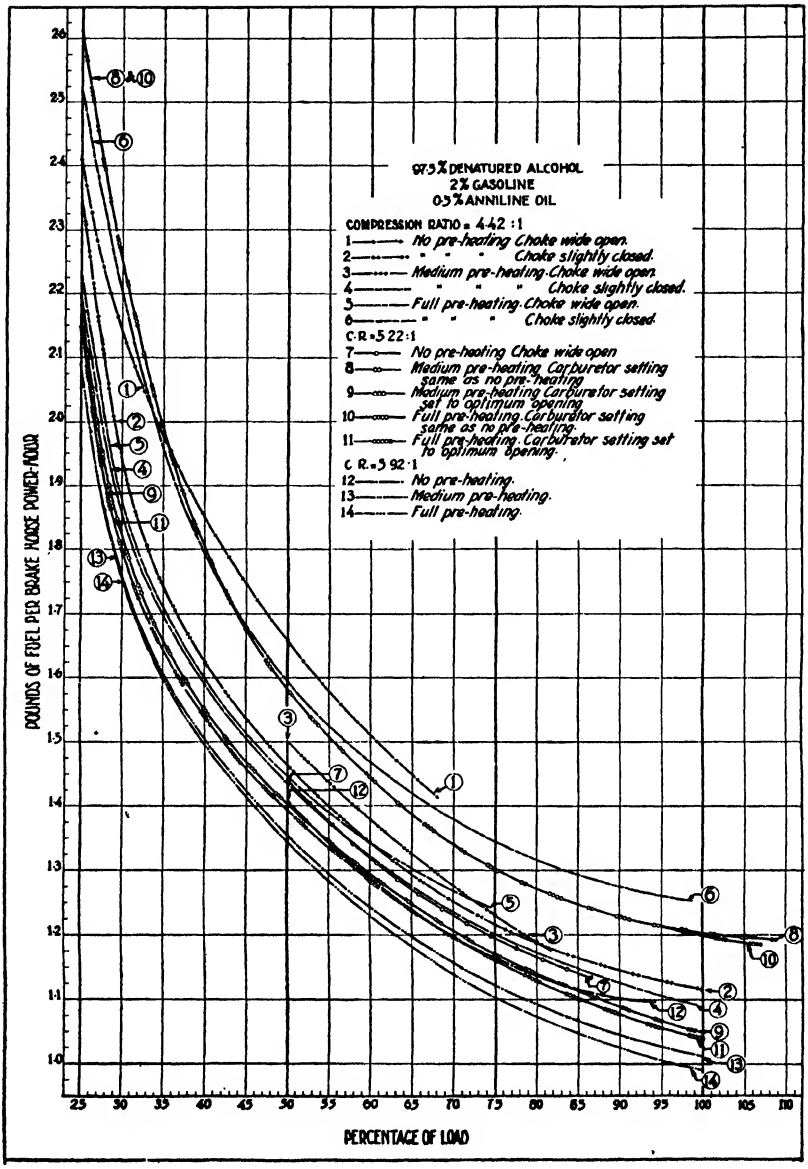

Chart 5.—Showing results of test using La Tondeña special denatured alcohol.

slopes downward near the maximum point does not only cross the medium pre-heating curve before it reaches the three-fourths load point but also definitely shows sign of flattening.

A very evident increase in the power developed was noted by choking the carburetor. An increase of from 5 to 10 per cent over the rated capacity was almost instantaneously shown by varying the degree of choking and by keeping the carburetor setting constant at the position best found with wide open choke. It was further noted that this setting could be reduced considerably without altering the operation of the engine or affecting the power developed. By carefully adjusting the fuel needle valve and the choke opening, it was possible, after many trials, to find a setting that gave an optimum economy at or very near the required power. The most economical opening found for no pre-heating test was 34 notches less than the best setting with wide open throttle. The reductions were 12 notches for tests with medium and 18 with full pre-heating.

A study of curves 2, 4, and 6a illustrates the following:

1. Slightly choking the carburetor from no load to about one-half load without pre-heating was not as economical as full pre-heating with wide open choke.

2. The fuel consumption as indicated by the curve with medium pre-heating was less than that without pre-heating from about 1½ per cent near the full load to about 7 per cent near one-fourth load.

3. An increase in consumption of from 12½ per cent at or near the full load to 7½ per cent near one-fourth load is indicated by the full pre-heating curve being greater than that of the curve without pre-heating.

The most economical curve under compression ratio 4.42:1 was obtained when medium pre-heating was used and when the choke was partly closed. Under this condition, normal operation was maintained very near the full load. Closing the choke more than was necessary gave a very poor fuel economy.

Compression ratio 5.22:1. The engine was able to develop only about 86.6 per cent of the rated power with no pre-heating and with wide open choke. Partly choking the carburetor, however, not only increased the power to full capacity but also made the consumption very high. Short tests showed an increase of over 5 per cent in fuel consumption at about 85 per cent of the load when operated in this condition. The choke lever did not seem to stay in the partly closed position unless firmly adjusted.

Pre-heating the mixture increased the power by about 8 per cent above the rated capacity when the carburetor opening was made

the same as the best adjustment found without any pre-heating and with wide open choke. It was further found that there was hardly any difference in the fuel consumption between tests with medium and with full pre-heating. (See curves 7 and 9.) From about 90 per cent to the rated load and the full pre-heating curve was more economical than the medium pre-heating by approximately only 1 per cent. The fuel consumption in both curves was rather high, being about 10 per cent more than without pre-heating.

The fuel consumption with pre-heating was from 3 to 4 per cent less than the consumption without pre-heating when the carburetor openings were adjusted to give the optimum consumption at the rated power. (See curves 8 and 10.) The curves clearly show that full pre-heating was only a little more economical than medium pre-heating.

The most economical curve using compression ratio 5.22:1 was obtained when full pre-heating was used and when the carburetor opening was adjusted to give the optimum supply at the rated power. Constant operation was maintained with wide open choke and without enlarging the carburetor jet.

Compression ratio 5.92:1. The maximum power developed at wide open choke without any pre-heating was approximately 94.3 per cent. Slightly choking the carburetor increased the power to more than the rated capacity. Short trial tests with the choke partly closed made very poor fuel economy. With the compression ratio of 5.92:1 it became necessary to secure the choke lever firmly in choke position so as to produce a constant operation under that condition.

Pre-heating the mixture showed economy, definitely, in fuel consumption compared with no pre-heating. The decrease in the amount of fuel used per brake-horsepower, however, with medium pre-heating was from about 8 per cent near the full load to about 3.5 per cent near one-fourth load. Full pre-heating had an effect of further decreasing the consumption from about 3 per cent at the rated load to about 1 per cent at half load. (See curves 12 and 13.) The pre-heating curves overlap from near this point to one-fourth load.

The most economical curve at compression ratio 5.92:1 was found when the engine was operated with full pre-heating and when the choke was kept wide open.

Using the size of a fuel jet best adapted for normal operation on either gasoline or kerosene, the following conclusions are shown, definitely, by these tests:

1. The rated power of the engine could not be developed under any circumstances if the choke was kept wide open.

2. Choking caused the engine to produce power even greater than the rated capacity.

3. It was indicated for higher compression ratios that the greater the pre-heating, the more economical was the fuel consumption. For a compression ratio suitable for normal operation on gasoline or kerosene, medium pre-heating showed better economy than either full-preheating or without any pre-heating.

4. Very poor fuel economy resulted when:

a. Too much choking was practiced with some degree of pre-heating.

b. The carburetor opening was not adjusted to give the minimum requirement. Over-rich mixture was hard to detect when alcohol fuel was used.

5. All other things being equal, the higher the compression ratio, the greater the power developed and the less the fuel consumption per brake horsepower hour.

Gasco (denatured alcohol)

The results of test using Gasco (denatured alcohol) are shown in table 6 and in chart 6.

Compression ratio 4.42:1. With double carburetor jet, the engine easily developed the rated capacity with and without pre-heating. It was easily possible to double the fuel consumption without its being detected by incorrect setting of the fuel needle valve. Short trial tests revealed that the optimum needle valve positions for tests with pre-heating were several notches less than the best setting without pre-heating. The needle valve was set at 1-19/64 notches for medium pre-heating, 1-22/64 notches for full pre-heating and 1-29/64 without any pre-heating.

The most economical curve with this compression ratio was obtained with medium pre-heating. The consumption compared with no pre-heating was from 8½ per cent less at the rated load to nearly 15 per cent less at one-fourth load. With full pre-heating, the reduction was only from 8 per cent near the full load to 13½ per cent at one-fourth load. (See curves 1, 2, and 3.)

Compression ratio 5.22:1. Without enlarging the carburetor jet, the maximum horsepower that could be maintained with constant operation was only 85.6 per cent for no pre-heating, 85.0 per cent for medium pre-heating, and 84.2 per cent for full pre-heating.

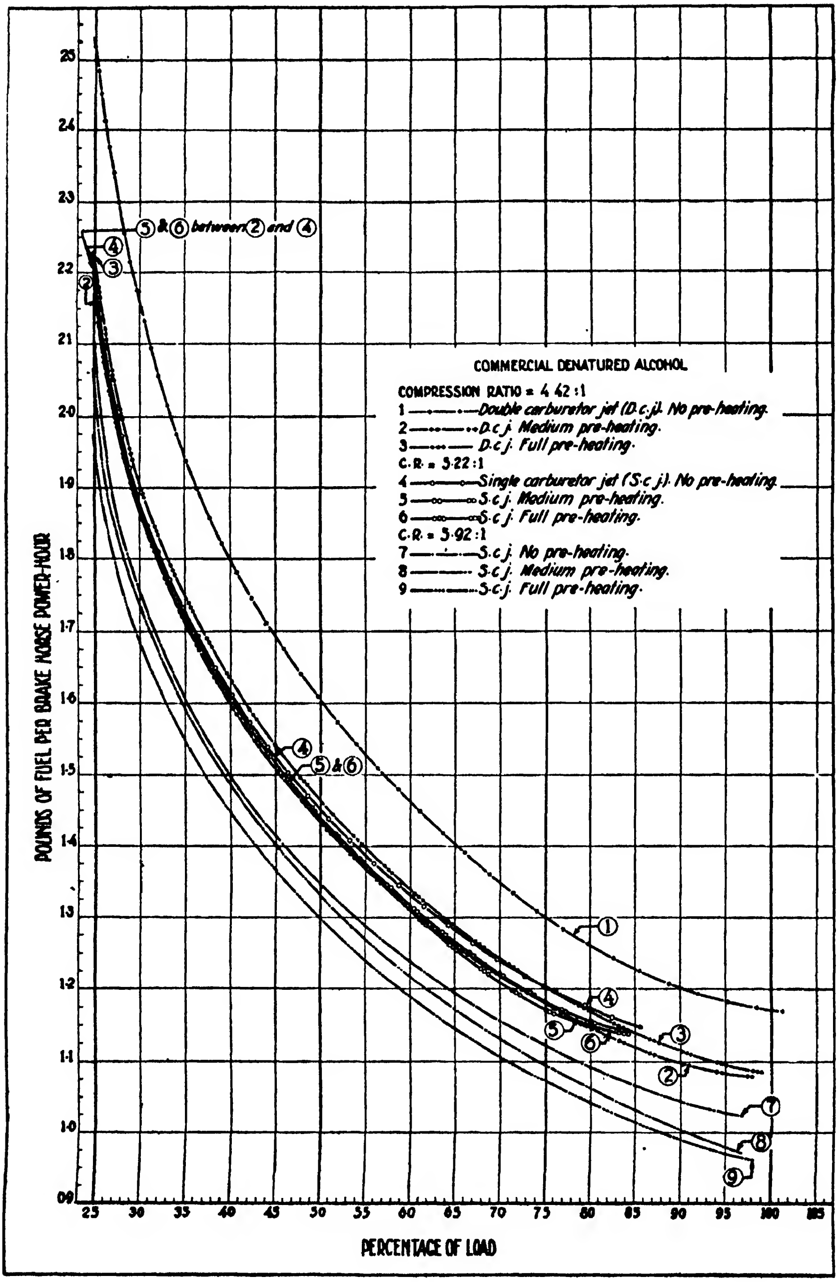

Chart 6.—Showing results of test using Gasco.

Short trial tests showed that as high as 90 per cent could be developed with pre-heating but the engine was somewhat shaky and showed signs of laboring.

It is indicated by curves 4, 5, and 6, that where the operation could be maintained constant with pre-heating, the consumption is a little more economical than without pre-heating. The decrease in fuel used compared with no pre-heating is scarcely over 1 per cent. As the curves also show signs of greater dispersion when the rated point is approached, it may be assumed that with a larger fuel jet opening, more fuel economy may be realized than could be obtained with the normal jet.

Compression ratio 5.92:1. With compression ratio 5.92:1, and using the normal jet opening, a rather unsteady operation was observed when the engine was made to run at the rated capacity. The maximum power that could be maintained at constant running was approximately 3 per cent less than the rated point. Very uneven operation was much in evidence with the full pre-heating on. When double jets were used, the engine easily developed 40 horse power without signs of laboring. Short trial tests further showed that with this compression ratio, there was hardly any measurable difference in the fuel consumption between single jet and double jets so long as the fuel needle valve was properly adjusted to give an optimum consumption.

The most economical curve was obtained with full pre-heating. The reduction in consumption was from 6.5 per cent near the full load to over 1½ per cent near one-fourth load more than that with no pre-heating. With medium pre-heating, the corresponding savings were only about 5.5 per cent and 2 per cent.

It was absolutely impossible for the engine to develop more than 63 per cent of the required capacity when it was run with wide open throttle and with the size of the jet the same as that suitable for gasoline and for kerosene. No degree of pre-heating could increase the maximum power developed. Slightly choking the carburetor, however, had the effect of suddenly increasing the power to even beyond the required point. By keeping the choke lever fixed at a certain choke position, the engine operated very satisfactorily and maintained constant operation at or near the rated load. Trial tests, each lasting about 10 minutes, showed a rather high fuel consumption at the choke position and an equally high if not higher consumption when pre-heaters were used. The increase in consumption when slightly choked at about 63 per cent of the load was about 10 per cent more than with open wide throttle.

The results of all tests using Gasco as a fuel point to the conclusions that:

1. The normal jet opening best adapted for gasoline or kerosene was too small to permit enough fuel to operate the engine constantly at full load with wide open choke. As the compression ratio was increased, the maximum power that could be developed was also increased.

2. Slightly choking the carburetor increased the power considerably. It also caused the engine to consume more fuel than would be necessary to run it with wide open choke.

3. The higher the degree of pre-heating the more economical the consumption per brake horsepower hour.

4. The higher the compression ratio, the less the consumption per brake horsepower hour.

SUMMARY OF CONCLUSIONS

The following observations may be drawn from the results obtained:

1. That without any alteration in the size of the original fuel jet and using the compression ratio adapted for either gasoline or kerosene, only those fuels containing 35 per cent of gasoline and over could run the engine at its rated capacity.

2. That alcohol and alcohol-gasoline blends did not require much pre-heating as did kerosene.

3. That with increased compression ratio the drop in power with much increase in heat was less in nearly straight alcohol fuels than in the blended ones. With little pre-heating, a small gain in fuel economy was observed.

TABLE 1

Consumption of Gasanol motor alcohol in pounds per brake horsepower-hour at fractional loads

1/4 LOAD	1/2 LOAD	3/4 LOAD	FULL LOAD	MAXIMUM POWER		REMARKS
Compression ratio—4.42:1						
1. 1.840	1.166	0.975	—	0.874	98.3%	No pre-heating; choke wide open.
2. 1.830	1.147	0.946	—	0.852	96.4%	Medium pre-heating; choke wide open.
3. 1.775	1.133	0.947	—	0.883	93.6%	Full pre-heating; choke wide open.
Compression ratio—5.22:1						
4. 1.731	1.118	0.920	0.827	0.827	100.0%	No pre-heating; choke wide open.
5. 1.658	1.081	0.891	0.783	0.782	101.0%	Medium pre-heating; choke wide open.
6. 1.658	1.081	0.892	—	0.828	93.7%	Full pre-heating; choke wide open.
Compression ratio—5.92:1						
7. 1.595	1.045	0.859	0.778	0.778	100.8%	No pre-heating; choke wide open.
8. 1.550	1.016	0.836	—	0.784	94.2%	Medium pre-heating; choke wide open.
9. 1.580	1.030	0.850	—	0.787	93.1%	Full pre-heating; choke wide open.

TABLE 2

Consumption of Gastarla motor alcohol in pounds per brake horsepower-hour at fractional loads

	1/4 LOAD	1/2 LOAD	3/4 LOAD	FULL LOAD	MAXIMUM POWER		CONDITION
			Compression ratio—4.42:1				
1.	1.830	1.179	0.970	0.868	0.866	100.8%	No pre-heating; choke wide open.
2.	1.825	1.172	0.960	—	0.859	97.0%	Medium pre-heating; choke wide open.
3.	1.770	1.150	0.949	—	0.871	95.0%	Full pre-heating; choke wide open.
			Compression ratio—5.22:1				
4.	1.770	1.129	0.930	0.827	0.828	102.0%	No pre-heating; choke wide open.
5.	1.734	1.110	0.912	0.827	0.828	100.2%	Medium pre-heating; choke wide open.
6.	1.734	1.122	0.920	—	0.828	98.9%	Full pre-heating; choke wide open.
			Compression ratio—5.92:1				
7.	1.692	1.090	0.898	0.790	0.785	101.2%	No pre-heating; choke wide open.
8.	1.645	1.065	0.880	0.789	0.787	102.2%	Medium pre-heating; choke wide open.
9.	1.691	1.071	0.880	0.798	0.797	101.0%	Full pre-heating; choke wide open.

TABLE 8

Consumption of Samson motor fuel in pounds per brake horsepower-hour at fractional loads

	1/4 LOAD	1/2 LOAD	3/4 LOAD	FULL LOAD	MAXIMUM POWER		CONDITION
			Compression ratio—4.42:1				
1.	—	1.381	1.151	—	1.061	89.9%	No pre-heating; choke wide open; single fuel jet.
2.	2.080	1.365	1.135	—	1.065	88.3%	Medium pre-heating; choke wide open; single fuel jet.
3.	3.170	1.772	1.518	1.388	—	—	Medium pre-heating; choke partly closed; single fuel jet.
4.	—	1.351	1.135	—	1.094	82.8%	Full pre-heating; choke wide open; single fuel jet.
			Compression ratio—5.22:1				
5.	2.140	1.335	1.097	—	0.999	97.2%	No pre-heating; choke wide open; single fuel jet.
6.	2.030	1.323	1.080	—	0.996	94.3%	Medium pre-heating; choke wide open; single fuel jet.
7.	2.005	1.295	1.060	—	0.986	93.5%	Full pre-heating; choke wide open; single fuel jet.
			Compression ratio—5.92:1				
8.	2.005	1.258	1.041	0.950	—	—	No pre-heating; choke wide open; single fuel jet.
9.	1.945	1.238	1.020	0.917	—	—	Medium pre-heating; choke wide open; single fuel jet.
10.	1.980	1.250	1.024	0.917	—	—	Full pre-heating; choke wide open; single fuel jet.

TABLE 4

Consumption of Kabankalan motor alcohol in pounds per brake horsepower-hour at fractional loads

	1/4 LOAD	1/2 LOAD	3/4 LOAD	FULL LOAD	MAXIMUM POWER		CONDITION
				Compression ratio—4.42:1			
1.	—	1.518	1.260	—	1.221	80.5%	No pre-heating; choke wide open; single fuel jet.
2.	3.135	1.965	1.680	1.565 [a]	1.565	99.4%	No pre-heating; choke partially closed; single fuel jet.
3.	2.665	1.440	1.205	1.087 [a]	1.087	99.6%	No pre-heating; choke wide open; double fuel jet.
4.	2.495	1.489	1.231	—	1.221	76.2%	Medium pre-heating; choke wide open; single fuel jet.
5.	2.580	1.440	1.225	—	1.122	94.7%	Medium pre-heating; choke partially closed; single fuel jet.
6.	2.430	1.490	1.205	1.089	—	—	Medium pre-heating; choke wide open; double fuel jet.
7.	2.370	1.457	1.220	—	1.211	76.2%	Full pre-heating; choke wide open; single fuel jet.
8.	2.356	1.470	1.205	1.090 [a]	—	—	Full pre-heating; choke wide open; double fuel jet.
				Compression ratio—5.22:1			
9.	—	1.486	1.215	—	1.108	89.5%	No pre-heating; choke wide open; single fuel jet.
10.	2.240	1.425	1.175	—	1.112	85.3%	Medium pre-heating; choke wide open; single fuel jet.
11.	2.190	1.430	1.186	—	1.135	83.7%	Full pre-heating; choke wide open; single fuel jet.
				Compression ratio—5.92:1			
12.	2.135	1.332	1.111	1.000	—	—	No pre-heating; choke wide open; single fuel jet.
13.	2.051	1.320	1.096	0.976 [a]	0.976	98.4%	Medium pre-heating; choke wide open; single fuel jet.
14.	1.991	1.320	1.096	—	0.981	97.5%	Full pre-heating; choke wide open; single fuel jet.

TABLE 5

Consumption of La Tondeña special alcohol in pounds per brake horsepower-hour at fractional loads

1/4 LOAD	1/2 LOAD	3/4 LOAD	FULL LOAD	MAXIMUM POWER		CONDITION
Compression ratio—4.42:1						
1. 2.410	1.659	—	—	1.413	68.00%	No pre-heating; choke wide open.
2. 2.345	1.461	1.215	1.115	—	—	No pre-heating; choke slightly closed.
3. —	1.500	1.230	—	1.175	81.7%	Medium pre-heating; choke wide open.
4. 2.195	1.435	1.200	1.091 [a]	1.091	99.2%	Medium pre-heating; choke slightly closed.
5. 2.230	1.445	1.240	—	1.240	74.85%	Full pre-heating; choke wide open.
6. 2.520	1.596	1.343	1.252 [a]	1.252	98.9%	Full pre-heating; choke slightly closed.
Compression ratio—5.22:1						
7. —	1.440	1.193	—	1.133	86.6%	No pre-heating; choke wide open.
8. 2.616	1.584	1.300	1.203	1.192	108.8%	Medium pre-heating; carburetor setting same as no pre-heating.
9. 2.163	1.400	1.169	1.050 [a]	1.050	98.8%	Medium pre-heating; carburetor set to optimum opening.
10. 2.616	1.584	1.300	1.200	1.185	107.00%	Full pre-heating; carburetor setting same as no pre-heating.
11. 2.150	1.392	1.160	1.039	—	—	Full pre-heating; carburetor setting set to optimum opening.
Compression ratio—5.92:1						
12. —	1.410	1.162	1.096	1.096	94.3%	No pre-heating.
13. 2.090	1.353	1.121	1.013	—	—	Medium pre-heating.
14. 2.090	1.348	1.100	0.990	—	—	Full pre-heating.

[a] Approximately at rated capacity.

TABLE 6

Consumption of Gasco (regular denatured alcohol) in pounds per brake horse-power-hour at fractional loads

1/4 LOAD	1/2 LOAD	3/4 LOAD	FULL LOAD	MAXIMUM POWER		CONDITION
Compression ratio—4.42:1						
1. 2.530	1.605	1.300	1.170	1.167	101.5%	Double carburetor jet; no pre-heating.
2. 2.203	1.435	1.180	1.078 [a]	1.078	98.2%	Double carburetor jet; medium pre-heating.
3. 2.230	1.465	1.202	1.083 [a]	1.083	99.2%	Double carburetor jet; full pre-heating.
Compression ratio—5.22:1						
4. 2.215	1.452	1.201	—	1.147	85.6%	Single carburetor jet; no pre-heating.
5. 2.215	1.442	1.180	—	1.140	85.0%	Single carburetor jet; medium pre-heating.
6. 2.203	1.441	1.167	—	1.137	84.2%	Single carburetor jet; full pre-heating.
Compression ratio—5.92:1						
7. 2.103	1.345	1.119	1.022 [a]	1.022	97.0%	Single carburetor jet; no pre-heating.
8. 2.070	1.330	1.095	0.971 [a]	0.971	97.0%	Single carburetor jet; medium pre-heating.
9. 1.975	1.298	1.072	0.960 [a]	0.960	98.2%	Single carburetor jet; full pre-heating.

[a] Approximately at rated capacity.

EFFECT OF VARIOUS METHODS OF STORING CORN ON THE DEGREE OF DAMAGE DUE TO WEEVILS[1]

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TWO TEXT FIGURES AND ONE CHART

There is an old established practice among farmers in many sections of the Philippines of keeping corn ears in storage with husks and stigmas on. The ears are hung by means of their cut stem pieces on fences, under or inside houses, or on especially constructed upright gratings of wood and bamboo. The husks and stigmas serve as a natural protection against attack by stored-grain insects.

Unfortunately, this method has its obvious limitations, because it is tedious and expensive. It is not generally applicable to the corn harvest, and is employed only in connection with seeds for planting. The rest of the crop is not infrequently shucked, sometimes shelled, and the products disposed of as quickly as the market will absorb them. The result is a glut in corn at certain times of the year and a dearth in other months. The methods of bulk storage practiced by both the farmer and the dealer, which are usually by keeping in sacks or in open bins, leave the kernels unprotected from destruction by insects and by rats, so that holding the corn for any length of time is almost invariably a losing business proposition. So brief and discontinuous is the supply that it is necessary in many places to raise two crops a year, one in the rainy season and one in the dry season. In the latter case, according to Dr. N. B. Mendiola, head of the Department of Agronomy, the yield is so poor that dry-season planting might more profitably be skipped if more adequate methods of conserving the rainy-season harvest could be available.

Back (1931) gives a comprehensive discussion of means whereby corn may be saved from insect damage in the gulf-coast states of

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the United States. With slight modification, his recommendations can probably be made applicable under Philippine conditions. Briefly, the points he brings out are:

1. Well developed, tight-fitting husks, if left intact, serve as adequate natural protection against invasion of the kernels by stored-grain insect pests. Such ears need no treatment.

2. Ears with poorly developed or damaged husks should be shucked and placed in cribs for fumigation. The author describes types of inexpensively constructed fumigating cribs that effectively ward off insects. Carbon bisulphide is recommended as a fumigant, at the rate of 7 to 14 grams for every cubic meter of space. The cribs must be tightly constructed, so as to minimize as much as possible the escape of gas. One of the wholesale dealers in Florida, where the weevil problem is bad, is reported as stating that "he can leave such corn [in the fumigating room], after it is fumigated, for several months with the perfect assurance that it will not be injured by weevils until he can find a profitable market for it." Reyes (1933), working in the Department of Agronomy at this College, observed that carbon bisulphide fumigation reduced insect damage in corn to 4.17 per cent when stored in iron tanks and to 5.83 per cent when stored in wooden boxes. He noted further that this method ranked second in efficacy, the first being with the use of naphthalene, by which infestation was reduced to only 0.27 per cent in iron tanks and 0.98 per cent in wooden boxes. Naphthalene, however, is objectionable in connection with products that are to be utilized as food because of the disagreeable taste it imparts.

3. Certain progressive farmers make it a practice to shuck and fumigate all corn, irrespective of the condition of the husks, for storage, because they do not want to take chances. Their contention is that in their regions "labor cannot be depended upon to separate properly the ears with a good and a poor husk covering, and where other factors, such as ear worms .... are more serious factors in lessening the protective value of the husk covering."

4. Where fumigation is resorted to, space is an important consideration. The following are the relative proportions of space occupied: shelled corn, 1; shucked corn, 1.8; slip-shucked corn, 2.3; corn with full shucks, 3.3.

GENERAL DESCRIPTION OF THE PRESENT WORK

The aim in the present work was to determine (1) the extent to which shucks and stigmas serve as a protection against weevil attack, and (2) conditions under which these structures may be taken

advantage of in the routine of corn storage, at least as a supplement to other methods.

The investigation was carried out at the College of Agriculture from August, 1931 to May, 1933, a period of twenty-two months.

Two main series of experiments were performed.

1. This series, conducted in 1931, consisted of five lots totalling 2161 ears of Native Yellow Flint corn, and treated as follows:

Lot 31-1. Shucked ears, piled on concrete floor, without previous exposure to sun, surface layer, 460 ears.

Lot 31-2. As in lot 31-1, bottom layer, 450 ears.

Lot 31-3. Shucked corn, kept in sacks after harvesting and shucking, 405 ears.

Lot 31-4. With husks and stigmas on, hung on racks for seed, exposed to sun, 430 ears.

Lot 31-5. As in lot 31-4, but under tree shade, 416 ears.

The material used in this series was part of the regular stock in the Department of Agronomy. The ears were kept in the seed house of department, for current use.

2. This series, conducted in 1932, consisted of five lots, totalling 2962 ears of Native Yellow Flint corn, as follows:

Lot 32-1. With husks and stigmas on, ears unselected, sun-dried to constant weight before storing, 700 ears.

Lot 32-2. With husks and stigmas on, ears selected on basis of full development of protective covers, sun-dried to constant weight before storing, 543 ears.

Lot 32-3. With husks and stigmas on, but husks broken or stigmas out, sun-dried to constant weight before storing, 700 ears.

Lot 32-4. Shucked and sun-dried to constant weight before storing, 667 ears.

Lot 32-5. As in lot 32-1, but not sun-dried before storing, 352 ears.

The lots were stored in a room in the Entomological Laboratory. The windows and door were kept closed, so as to simulate, as far as practicable, the average conditions obtaining on the farm or in the dealers' store rooms.

The unit used in gauging infestation was the ear. At the close of the period of storage, the material in the various lots was gone over carefully, and the numbers of sound and of infested kernels recorded, separately for each ear.

INSECTS INFESTING STORED CORN

The most injurious and in many cases the only notably bad insect pest of corn in storage in the Philippines is *Calendra oryzae* Linnaeus (Calendrinae, Curculionidae, Coleoptera). It may safely be assumed that over ninety-five per cent of the insect damage to

stored whole corn kernels in this country is due to this species. It is a cosmopolitan pest, having been carried by commerce to nearly all countries of the world. It is, however, more at home in tropical and subtropical climates than in temperate. In colder countries, the dominant form is its congener *Calendra granaria* Linnaeus, which is either very rare or of doubtful occurrence in the Philippines.

Calendra oryzae passes its immature life in the kernels of corn, rice, and other cereals. The adult weevils have a wide range of food, the records, as compiled by Cotton (1920), in addition to cereals or their derivatives, including chickpeas, table beans, chestnuts, cashew nuts, seeds of "*Nebulium* sp." (? *Nelumbium* sp., Nymphaeaceae), hemp seed, tobacco, peaches, grapes, apples, and mulberries. The same author reports finding rice weevils to burrow and feed in "berries of the Chinaberry tree, in both Irish and sweet potatoes, and in the seed of avocado. In the laboratory they showed a liking for most kinds of ripe fruits, and it was found that they could live indefinitely on a majority of the wild berries growing in the vicinity of the laboratory." In the present work, we have encountered adult weevils feeding on copra meal, cassava meal, and taro, yam, and other root crops, but have so far failed to find them on fruits. The larvae are more selective in their choice of food, the only other alternatives to cereals recorded being chickpeas, acorns of several species of oaks, galls of *Phylloxera devastatrix* on *Hicoria pecan,* and old cotton bolls (Cotton, 1920).

The following additional species of insects were collected on stored corn in the present work:

LEPIDOPTERA

Ephestia elutella Hübner (Phycitidae)
Pyralis farinalis Linnaeus (Pyralidae)

COLEOPTERA

Tribolium ferrugineum Fabricius (Tenebrionidae)
Alphitobius laevigatus Fabricius (Tenebrionidae)
Oryzaephilus surinamensis Linnaeus (Cucujidae).
Laemophloeus pusillus Schönherr (Cucujidae)
Araeocerus fasciculatus De Geer (Anthribidae)
Rhizopertha dominica Fabricius (Bostrichidae)
Tenebroides mauritanicus Linnaeus (Ostomidae)
Attagenus undulatus Motschulsky (Dermestidae)
Carpophilus dimidiatus Fabricius (Nitidulidae)

Ephestia elutella, Tribolium ferrugineum, and *Rhizopertha dominica* are sometimes bad on rice and other stored products, like cassava starch and similar root derivatives. *Tribolium ferrugineum,*

likewise, occurs abundantly on copra meal and dried shrimps. *Araeocerus fasciculatus* is the so-called coffee weevil in Java; it has a wide range of food, especially where the seeds or fruits contain some starch. *Pyralis farinalis, Attagenus undulatus, Alphitobius laevigatus,* and *Oryzaephilus surinamensis* exhibit a similar predilection for starchy food products. In the case of stored corn seeds, however, all the species included in the foregoing list were found on corn in the present work only after the kernels were badly injured from the attack of *Calendra oryzae.*

Sitotroga cerealella Olivier (Gelechiidae, Lepidoptera), the Angoumois grain moth, probably vies at times with *Calendra oryzae* in destructiveness to unhulled and hulled rice in the Philippines, but so far we have not collected it on corn kernels.

Some of the species in the foregoing list have apparently other relations with corn than as primary pests. *Carpophilus dimidiatus* probably feeds largely on the fungus growing on the damaged corn as substratum. *Laemophloeus pusillus* is probably more beneficial than injurious, because it is known to prey on other insects. Flanders (1930), for instance, observed it in California to attack newly hatched larvae of *Sitotroga cerealella.* Likewise, Fletcher, as cited by Cotton (1920), noted that *Tenebroides mauritanicus* was predatory on adult rice weevils in India. Okuni (1924) reports a similar behavior of that species in Formosa. His paper, incidentally, apparently contains some pertinent data on grain conservation against weevils, although these were not readily comprehensible to the present workers, because written in Japanese.

In the present paper, only *Calendra oryzae* is considered, not only because it was practically the only injurious species noted in our cultures, but also because treatment of the seeds with a view to its control would also work against whatever insect pests may threaten the stored grain.

PARASITES OF CALENDRA ORYZAE

At least three species of chalcidoid parasites were collected on our cultures after the damage due to weevils had been rather far advanced. It does not appear that these natural enemies exert very marked influence in the way of minimizing infestation.

RELATION OF CALENDRA ORYZAE TO PHYSICAL FACTORS

Dendy and Elkington (1920) report that this species, as well as *granaria,* when reared in a dry incubator at a temperature of from 16° to 22.7°C., requires 10 per cent humidity in the wheat in order

to attain normal development. Similarly, Chapman (1931) states that the rice weevil will not develop in grain with less than 10 per cent moisture and will, if given a choice, select grain of high moisture-content. According to Zacher (1926), the presence of 15 to 16 per cent moisture in the seeds is required for optimum development of *Calendra oryzae*. However, he does not state how he arrived at this conclusion.

Apparently we have little exact knowledge of the reaction of *Calendra* to temperature beyond the experimental results of Dendy and Elkington, who found that the adults of the grain weevil were killed at a temperature of 48.9°C. in a minimum time of three minutes. Back and Cotton (cited by Imms, 1931) are reported to have observed that both the rice and the grain weevils of all stages were killed upon exposure for one hour at a temperature of 47.8° to 48.9°C. Paller (1929), working at this College and using higher temperature ranges, records that larvae, pupae and adult weevils in corn seeds "perished when heated gradually to 50°C. for 45 minutes, 55°C. for 20 minutes, 60°C. for 10 minutes, and less than a minute at 65°C." He notes, moreover, that corn grains could be heated for one hour to as high as 65°C. without injury.

MOISTURE CONTENT OF CORN KERNELS AND WEEVIL DAMAGE

It will be seen from the figures cited above that the amount of moisture present in grains is an important consideration in storage, especially since, as is generally the case in the Philippines, neither previous disinfesting measures nor use of insect-proof containers are resorted to as a means of reducing weevil damage. Under favorable conditions infestation can start easily from three sources: (1) Adult weevils flying from outside sources and gaining admittance into the bins. (2) Ears with defective husk protection that begin to be infested in the field. (3) Containers used from season to season without thorough cleaning between times, thus leaving food, especially in crevices, for the insects to breed in continuously.

The moisture-content of freshly harvested corn is very high, as shown by the following figures on corn kernels from ripe ears which were picked on September 7, 1933, and analyzed on the same day: sample I, 27.62 per cent; II, 27.44; average, 27.53. These figures, however, represent conditions for the rainy-season crop. The kernels in the dry-season may possibly contain somewhat less moisture. That the excess moisture is rapidly given up, even if the ears are kept in shade, is indicated by the data accompanying lots 5 and 7, table 1, which, after about a month, from harvesting on March 14,

1933, until moisture determinations were made on May 19, 1933, showed an average of only 10.38 per cent for unhusked ears and 10.29 per cent for shucked ears. However, although by this time the original moisture in the kernels was reduced to nearly one-third, still it remained above the minimum effective limit for development of the rice weevils.

As shown in table 3, the presence of fully formed enveloping husks and stigmas (lots 32-1 and 32-2) interfered but little with sundrying, these ears having attained constant weight after 32 days of treatment, or a total sun exposure of 88 hours. The ears that were shucked or with the husks and stigmas broken off (lots 32-3 and 32-4) required 28 days or a total sun exposure of 72 hours, thus shorter only by 4 days, or by a total sun exposure of 16 hours.

As regards reduction of moisture-content (table 1), the end results, likewise, showed no material difference with respect to presence or absence of enveloping husks and stigmas. This fact is evident upon comparison of lots 1 and 4 (table 1) for the sundried ears and of lots 5 and 7 for those kept in shade.

It must be pointed out in this connection, however, that our results on sundrying were obtained during the summer months, when there was little cloudiness and practically no rainfall. The time required for sundrying in the rainy months will of course be longer. Experiments are now in progress along this line.

Lot 6 (table 1) consisted of shucked ears that were dried in an electrically heated oven at an upper temperature range of between 45° and 48°C., or about the lethal temperature for *Calendra oryzae*. Heating was intermittent, to simulate roughly the lengths of daily exposure in sundrying, in order that a fair comparison could be made with the latter process. It will be seen that after the ears reached constant weight there was little if any difference in the moisture-content of the kernels between the sundried lot (lot 4) and the oven-dried; in fact, there was a slight, although probably insignificant, discrepancy in favor of the former. It took the two lots the same length of time, 24 days, to dry to constant weight. Hence, assumption is probably justified that sundrying on cement floor, such as we had done with the sundried lots, compared favorably in efficiency with drying in an oven where heat could be controlled. No determination was made of the temperature within the kernels when the ears were under exposure in the midday sun, so that we were unable to tell whether or not it was high enough to kill the various stages of the weevils that might be present therein. The fact, however, that the moisture-content was reduced to an average of 8.5 per cent,

which is below the amount needed by the weevils for development, would probably insure the seeds against infestation if outside moisture could be excluded. For that matter, the low moisture-content, rather than the destruction of weevils by heat, probably was responsible for the success attained at the Station for Annual Crops in Buitenzorg, Java, as reported by Mendiola (1924), and subsequently in the Department of Agronomy of this College in keeping corn seed pest-free by first sundrying the grains to constant weight and, while still hot from exposure, putting these into empty kerosene cans that were likewise sun-heated. The small openings at the tops were then soldered. Mendiola notes that "corn seed kept in this way did not lose the vitality after a year or even 15½ months of storage, and was never attacked by weevils or moths."

When the ears were not stored in air-tight containers but just piled in a room on a cement floor, the average moisture-content of the kernels subsequently increased through absorption of atmospheric humidity. It will be seen in table 2 that after about seven months of storage the moisture-content of kernels in the sundried ears and that in the unexposed lots were approximately the same. Here again, the presence or absence of enveloping husks and stigmas apparently exerted no influence. The close similarity of the figures for the different lots, including lot 32-5, is probably an indication that an average moisture content of 12.19 to 12.88 per cent more or less represents a state of equilibrium in the kernels, under the storage-room conditions prevailing during the time of storage. The mean temperature in an adjoining room for this period from April 13, 1932, to November 12, 1932, was 28.28°C. $\pm$ 0.06, standard deviation = 1.21 $\pm$ 0.04, and coefficient of variation = 4.26 $\pm$ 0.14 per cent; the relative atmospheric humidity, 72.92 $\pm$ 0. 67 per cent, standard deviation = 8.04 $\pm$ 0.26, and coefficient of variation = 11.02 $\pm$ 0.36 per cent. The mean temperature was computed from the daily maxima and minima and the relative humidity, from three daily readings, at 8:00 a. m., 12.00 m., and 4:00 p. m.

How soon during storage the dry kernels absorbed sufficient moisture from the air to restore favorable conditions for *Calendra oryzae* has not been accurately determined in the present work. We noted, however, that all the lots described in table 2 were visited by weevils in at least one and one-half months of storage, from which it may be inferred that the moisture-content, even in the sundried lots, must have increased by then to around 10 per cent. Hence, drying the kernels and subsequently leaving them exposed gives them only a relatively brief respite from weevils.

That, unless due precautions are taken, the stage is always set for weevil invasion and damage may be seen upon examination of the figures in table 4, wherein a comparative study is made of infestation of shucked corn ears that had been kept only 36 to 38 days from harvest without previous drying. Lots 31-1 and 31-2, in a room with a concrete floor, showed over 1 per cent infestation, with the bottom layer slightly more damaged than the top layer, presumably owing to retention of a larger amount of moisture as a result of impeded air circulation and probably also to exclusion of light playing on the tropic responses of the ovipositing weevils. The influence of these factors, especially that of humidity, is further emphasized in lot 31-3, which consisted of shucked corn ears that had been stored 38 days in closed sacks without previous drying; the infestation was nearly five times as severe as in the other two lots. The presence of a large amount of moisture in this last lot moreover resulted in the blasting of most of the kernels due to fungus growth.

Fig. 1.—*Above*: Defective shucks and stigma which encourage, rather than deter, weevil infestation. *Below*: Fully formed shucks and stigma, an efficient natural protection against weevil damage on dry ears.

The gradation in distribution of damage due to weevils in the three treatments may be seen clearly in perspective on comparing the coefficients of variation, which was least (indicating greatest uniformity of infestation) for lot 31-3 and highest for 31-1.

PROTECTIVE VALUE OF ENVELOPING HUSKS AND STIGMA

Lot 32-2 (tables 7 and 8) stood in marked contrast with 32-4 both in the much smaller amount of damaged kernels and in the erratic nature of infestation in the former. The former consisted of ears with close-fitting husks and stigmas; the latter of shucked. The material in both lots was sundried to constant weight and then stored for about seven months on a cement floor in a room to which weevils had free access. On an average farm, perhaps no farmer would face the necessity of holding his crops for a longer time. Likewise, in seven months, the pest must have passed through a succession of several generations of weevil population in the storage room. Hence, we believe that results in these two, as well as in any of the other lots in the series included in tables 7 and 8, would not be vitiated by the possible uncertainty of a source from chance invasion from without. Hinds and Turner's (1911) and Cotton's (1920) figures of a life cycle of about a month for *Calendra oryzae* in warm weather in southern United States probably holds true for our local conditions. The percentage of infested kernels in lot 32-2 was but about one-half that in 32-4. The coefficients of variation show that the weevils were over six times as thorough in their work on the latter as on the former. The protection given by the shucks and stigmas is in fact evident throughout the series, when a comparison is made of the coefficients of variation in table 7.

While lot 32-2 was composed of ears that were especially selected for full shucks and long, bushy stigmas, lot 32-1 contained ears, also sundried with husks and stigmas intact, but only picked from the piles at random, the only precaution taken being to remove those with very poor covers where the kernels were partially exposed. The figures show a difference of 2.29 ± 0.09 per cent infestation against the unselected lot, while the coefficients of variation were 191.58 per cent for the unselected, or about 0.7 that of the selected. The infestation was 5.59 per cent less than, or 0.69 as great as, that of the shucked lot 34-4, while the coefficients of variation is about 4.5 as much. It may be deducted from these comparisons that the ordinary run of Yellow Flint corn ears, except those with kernels showing through broken or imperfect husks, possess fairly adequate protection in their natural covering against weevil damage. Where it is impracticable, therefore, to practice rigid selection, resort may be had, at but slightly greater disadvantage, to this less discriminating alternative.

Leaving broken and imperfectly covering husks on was found inadvisable in that it enhanced rather than deterred infestation, as is shown by data accompanying lot 32-3, of which the sundried ears had broken husks or pulled-out stigmas. It is obvious that with the weevils gaining a foothold on the exposed kernels, they could with little effort crawl underneath the partially loosened husks and work while hidden under the protective cover with little interference from natural enemies or other environmental factors.

Presence of full shucks and stigmas is disadvantageous if the ears are not dried. This is proved definitely by lot 32-5, in which

Fig. 2.—*Above*: Weevil damage on shucked ear after seven months in storage. *Below*: Ear with sound kernels, owing to protection by well-formed shucks and stigma.

infestation was about three times as much as in the sundried lots with perfect covering and nearly twice as much as in the sundried shucked ears. Protection by full shucks and stigmas, therefore, may be counted on only if these are taken advantage of in combination with sundrying of the ears to constant weight.

A comparative study of the figures given in tables 7 and 8 and chart 1 will enable one to evaluate the relative merits of the various treatments used. The close correspondence for all the lots of the coefficients of variation of the mean total number of kernels to the ear, in table 6, is an indication that the contrasting results given for

degrees of infestation could not have been unduly subject to error from such disturbing factors as differences in inherent variability of material used for the different treatments.

Incidentally, it may be pointed out in this connection that rats did not begin to destroy the kernels in the husk-covered ears until after these had been shucked for examination. Evidently, husks serve to furnish at least partial protection from rats.

HANGING EARS WITH FULL SHUCKS AND STIGMAS ON UP-RIGHT GRATINGS

Only a limited amount of work was done by us in the way of determining the efficacy of this method, as practiced by Filipino farmers for storing seed corn, against weevil damage. Table 5 gives the results of our survey on two lots after two and one-half months of storage. The data are not comparable with those given in the other tables on account of the great discrepancy in time covered, so that we are not in a position to judge whether or not this method has anything in its favor over others.

One matter of interest that we noted in the present work is the sizable difference in rate of infestation between ears set on racks that were kept in the sun throughout the day (lot 31-4) and those on racks that caught only a part of the morning sunshine because shaded by balimbing (*Averrhoa carambola* Linnaeus. Oxalidaceae) trees and the large concrete tool room of the Department of Agronomy the rest of the time (lot 31-5). Contrary to what might be expected, lot 31-5 fared the better, its infested kernels representing less than half that of 31-4. The coefficient of variation, likewise, was about twice as great. These results are puzzling and certainly defy explanation, in view of the poor results that we obtained with unhusked corn that had not been sundried (lot 32-5). Perhaps, the free air circulation together with the limited amount of sun exposure was sufficient to reduce to a safe level the moisture-content of the kernels in lot 31-4. On the other hand, lot 31-5 was quite possibly over-exposed so that the alternating rain, dew, and bright sunshine very likely split the husks open in parts and allowed weevil invasion.

The extraordinarily high coefficients of variation in infestation of both lots cannot be taken as an indication of their greater merit over room storage in warding off weevil damage. Because the enveloping husks and stigmas keep the kernels from uniform exposure to unimpeded invasion by weevils, fluctuation in degree of attack must at first be great in all ears that possess this natural protection. The coefficient becomes reduced as time goes on, when the pest becomes more securely established among the corn ears.

SUMMARY AND CONCLUSIONS

The most injurious of the various pests of stored corn, and practically the only form found to do damage on whole corn kernels in the present work, was *Calendra oryzae* Linnaeus (Calendrinae, Curculionidae, Coleoptera). In addition, eleven other species of insects that were found to appear later on weevil-damaged corn are listed and discussed.

Several species of chalcidoid parasites were collected from weevil-infested corn, but not until after the damage was well under way, indicating apparently that these natural enemies were of but little help in minimizing injury.

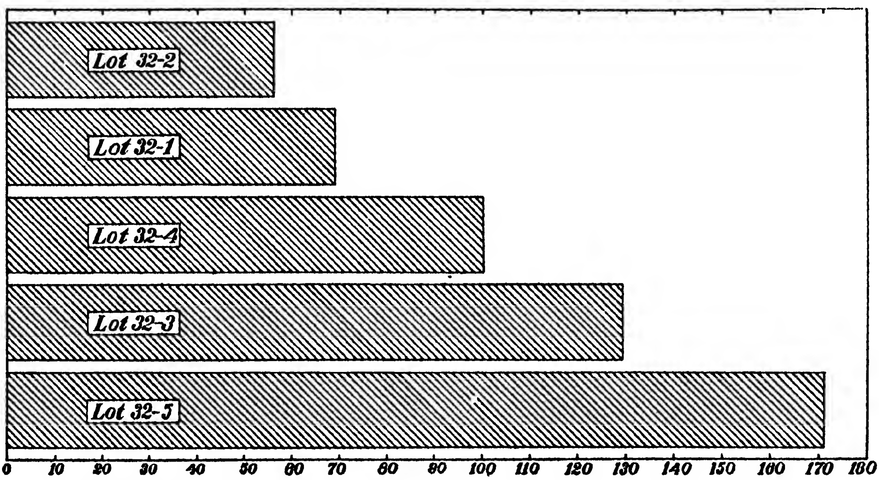

Chart 1.—Relative degrees of weevil damage on corn kernels under various conditions; lot 32-4=100. Based on table 8. For descriptions of the different treatments, see text, page 655.

With the average storage-room temperature of 28.28°C. and relative atmospheric humidity of 72.92 per cent, which prevailed during the period of observation, moisture-content of the kernels appeared to be the most important factor in determining degree of infestation.

The moisture-content of corn kernels on ears, either shucked or with full husks and stigmas on, when sundried to constant weight was reduced to 8.53 to 8.55 per cent, which are below the minimum required by *Calendra oryzae* for development. It took shucked ears about 28 days or a total sun-exposure of 72 hours to dry; ears with full husk and stigma, 32 days or a total sun-exposure of 88 hours.

Drying was done in the present work during the summer months, when there was little or no cloudiness and almost no rainfall.

Drying in an electrically heated oven at an upper temperature range of about 48°C. gave practically the same results as sundrying with respect to length of time required to attain constant weight and moisture-content of the kernels.

Weevils began to infest the dried ears in at least one and one-half months of storage, indicating that the moisture-content of the kernels must have increased then to at least 10 per cent, which is the minimum effective moisture for *Calendra oryzae*.

The moisture-content of kernels at harvest was determined to average 27.53 per cent. Excess moisture was quickly given up even when the ears were stored in the shade, so that after about a month the figures were reduced to an average of from 10.29 to 10.38 per cent. In about seven months of storage, the amount of moisture in the kernels rose in all the ears, irrespective of treatment, to an average of from 12.19 to 12.88 per cent. The closeness of these last figures for the shucked and unshucked ears, for the sundried and for those kept without previous exposure, would seem to indicate that these amounts more or less represent a state of equilibrium for the moisture-content of the kernels in the atmospheric temperature and relative humidity prevailing in the storage room.

Because of the presence of the requisite amount of moisture in the kernels, weevil infestation apparently proceeds in untreated kernels soon after harvest, so that after five weeks in storage under shade, the percentage of damaged ears averaged from 1.17 to 5.18 per cent, the lower figure for the top layer of piled ears, where air could circulate freely, and the higher for those that had been kept in closed sacks after harvest, with the consequent longer retention of moisture-content. The coefficients of variation, likewise, which was 129.33 and 94.05 per cent, respectively, showed decided preference of the weevils for the latter.

After about seven months of storage, the shucked and sundried ears showed an average of 17.95 per cent damaged kernels.

The uniformly higher coefficients of variation of infestation in all the lots wherein the husks and stigmas were not removed (125.28 to 255.94 per cent) as compared with that in the shucked-ear lot (42.36 per cent), after seven months of storage, point to a decided weevil-excluding trend of this natural protection.

Sundried ears, selected with full, tight-fitting shucks and stigmas, after seven months in the storage room, had only 10.07 per cent of the kernels damaged, or 56 per cent that of the shucked ears.

Sundried ears with shucks and stigmas intact but without selection, except for removal of those with broken or imperfect shucks that exposed the kernels, showed in the same length of time only a slight increase in damaged grains, 12.36 per cent.

Weevil damage in ears with broken or imperfect husks was 23.16 per cent, or 129 per cent that in shucked ears.

Ears with shucks and stigmas on but stored without previous sundrying suffered the highest weevil damage, which was 30.78 percent of the kernels, or 171 per cent that in shucked and sundried corn.

Hence, shucks and stigmas can be depended on to protect the kernels only when these are not broken or imperfect and when the ears are sundried before storage. Otherwise, they encourage rather than deter infestation.

Shucks on ears apparently serve, likewise, as a partial protection from rats.

Ears with full shucks and stigmas, when hung on racks that were shaded for the greater part of the day, showed, after two and one-half months, an average of 1.12 per cent weevil damage in the kernels, as against 3.76 per cent in those that were exposed the whole day. The coefficient of variation for damage in the former was 655 per cent; in the latter, 344.36 per cent. It appears that, contrary to results under storage-room conditions, partial shade tends to give better results for rack drying than a continuous exposure. An explanation is offered that the ears on racks in the open became over-exposed, with resulting cracking and tearing out in parts of the husks.

No comparable results were obtained in the present work between open-air rack and indoor storage.

All the data given above apply to Native Yellow Flint corn, which was used exclusively in the present work.

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TABLE 1

Moisture-content of corn kernels at beginning of storage [a]

LOT	TREATMENT	MOISTURE I	MOISTURE II	MOISTURE Average
		per cent	*per cent*	*per cent*
1	Unhusked ears, sundried	8.72	8.38	8.55
4	Shucked ears, sundried	8.31	8.75	8.53
5	Unhusked, in shade	10.21	10.54	10.38
6	Shucked, drying chamber	8.63	8.80	8.72
7	Shucked, in shade	10.22	10.35	10.29

[a] Treatment completed, May 19, 1933; moisture determinations made, May 19, 1933.

TABLE 2

Moisture-content of corn kernels after 214 days of storage [a]

LOT	TREATMENT	MOISTURE I	MOISTURE II	MOISTURE Average
		per cent	*per cent*	*per cent*
32-1	Unhusked, unselected, sundried	12.82	12.94	12.88
32-2	Unhusked, selected, sundried	12.26	12.54	12.40
32-3	With defective husks or stigmata, sundried	12.20	12.18	12.19
32-4	Shucked and sundried	12.36	12.13	12.25
32-5	As in 32-1, but kept under shade	12.46	12.67	12.57

[a] Treatment completed April 13, 1932; moisture determinations made November 12, 1932. For further details as to treatment see text, page 655.

TABLE 3

Number of days required to dry corn by various methods [a]

LOT	HARVESTED	CONSTANT WEIGHT	DURATION OF TREATMENT	TOTAL SUN EXPOSURE
	1932	*1932*	*days*	*hours*
32-1	10-III	11-IV	32	88
32-2	10-III	11-IV	32	88
32-3	10-III	7-IV	28	72
32-4	10-III	7-IV	28	72
32-5	10-III	—	—	—

[a] For descriptions of treatment, see table 2 and text on page 655.

TABLE 4

Weevil damage on undried shucked corn 36 to 38 days after harvest

LOT	NUMBER OF EARS	HARVESTED	SURVEYED	TIME OF STORAGE	TREATMENT IN STORAGE	KERNELS INFESTED		
						Mean	Standard deviation	Coefficient of variation
		1931	*1931*	*days*		*per cent*	*per cent*	*per cent*
31-1	460	14-IX	20-X	36	Shucked, piled on cement floor, top layer	1.17 ± 0.05	1.51 ± 0.03	129.33 ± 2.80
31-2	450	14-IX	22-X	38	As in 31-1, bottom layer	1.59 ± 0.06	1.72 ± 0.04	107.98 ± 2.43
31-3	405	14-IX	22-X	38	Shucked, kept in sacks	5.18 ± 0.16	4.87 ± 0.12	94.05 ± 2.23

TABLE 5

Weevil damage on corn ears with close-fitting husks and stigma, on racks [a]

LOT	NUMBER OF EARS	TREATMENT	KERNELS INFESTED		
			Mean	Standard deviation	Coefficient of variation
			per cent	*per cent*	*per cent*
31-4	430	Exposed to sun .	3.76 ± 0.48	12.95 ± 0.30	344.36 ± 7.92
31-5	416	Under tree shade	1.12 ± 0.24	7.34 ± 0.17	655.00 ± 15.32

[a] Harvested August 22, 1931; surveyed November 5-6, 1931; length of storage, 75-76 days.

TABLE 6

Mean total number of kernels to a corn ear [c]

LOT	NUMBER OF EARS	KERNELS TO AN EAR		
		Mean	Standard deviation	Coefficient of variation
		number	*number*	*per cent*
32-1	700	385.8 ± 2.22	86.96 ± 1.57	22.54 ± 0.41
32-2	543	412.7 ± 2.21	76.32 ± 1.56	18.49 ± 0.38
32-3	700	391.4 ± 2.10	84.91 ± 1.53	21.69 ± 0.39
32-4	667	378.0 ± 2.03	77.83 ± 1.44	20.59 ± 0.38
32-5	352	390.5 ± 4.32	80.88 ± 2.06	20.71 ± 0.53

[c] For descriptions of lots, see table 2 and text on page 655.

TABLE 7

Weevil damage on corn ears under various treatments; 214 days in storage [a]

LOT	NUMBER OF EARS	KERNELS INFESTED		
		Mean	Standard deviation	Coefficient of variation
		per cent	*per cent*	*per cent*
32-1	700	12.36 ± 0.60	23.68 ± 0.43	191.58 ± 3.45
32-2	543	10.07 ± 0.75	25.77 ± 0.53	255.94 ± 5.24
32-3	700	23.16 ± 0.80	31.52 ± 0.57	136.10 ± 2.45
32-4	667	17.95 ± 0.20	7.60 ± 0.12	42.36 ± 0.78
32-5	352	30.78 ± 1.35	38.56 ± 0.98	125.28 ± 3.19

[a] For descriptions of lots, see table and text on page 655.

TABLE 8

Comparison of mean infestation in table 7, with lot 32-4 as standard

LOT	DIFFERENCES OF MEANS	LOT 32-4 = 100	PROPORTION OF C. OF V.
	per cent		
32-2	− 7.88 ± 0.78	56	6.04
32-1	− 5.59 ± 0.63	69	4.52
32-3	+ 5.21 ± 0.82	129	3.21
32-5	+12.83 ± 1.36	171	2.96

CHEMICAL ANALYSIS OF THE WATER SUPPLY OF THE COLLEGE OF AGRICULTURE FOR THE YEAR 1931-32 [1]

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The object of this work was to present data on the chemical analyses of the different water supplies of the College of Agriculture with a view to giving some information on their sanitary quality and mineral composition.

In the sanitary analysis of water, the following are usually determined: color, odor, chlorides, free and albuminoid ammonia, nitrites, nitrates, oxygen-consuming capacity and total solids.

Color and odor determinations which are often included in chemical sanitary analyses afford physical indications of the pollution of water sources.

Haywood (1902) gives the following interpretations of results of water analysis: "A high amount of *chloride* may indicate contamination from sewage if other waters in the same region or district are not high in chloride content.

"*Free ammonia* is not injurious in itself (in the amount that it is usually present) but indicates that nitrogenous organic matter has been present.

"A large amount of *albuminoid ammonia* usually indicates that organic matter, in a fresh or semiputrid condition, is present."

Nitrites which are transition products in the oxidation of ammonia into nitrates usually indicate active fermentation going on in the water analyzed. When present as an intermediate product in the reduction of nitrates, nitrites indicate the presence of reducing substances such as ferrous iron.

Haywood further stated that "*nitrates* in water are the final oxidation product of the nitrogen of organic matter, and when present in at all large quantities indicate that nitrogenous organic matter (especially animal matter) has been present in the water and has been oxidized. Because a large amount of the nitrogen of organic matter has been converted by oxidation into harmless nitrates it does not necessarily follow that the water is fit for use, since bacteria may remain which would give rise to disease. Nitrates are

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[1] Experiment Station contribution No. 941.
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present in nearly all waters in small amounts, and the amount naturally present is much higher in some localities than in others. A 'local normal', therefore, is of great aid in judging of the purity or non-purity of any particular sample in so far as nitrates are concerned."

Oxygen-consuming capacity. In the absence of reducing substances such as ferrous salts, sulfides, nitrites and hypochlorites, the oxygen consumed gives an idea as to the relative amount of carbonaceous organic matter present and in conjunction with albuminoid ammonia it indicates what kind of organic matter predominates. According to Haywood, high albuminoid ammonia content and high oxygen-consuming capacity mean organic matter of vegetable origin. High albuminoid ammonia content and a relatively low oxygen-consuming capacity indicate organic matter of animal origin.

According to Heise and Aguilar (1916), "the determination of oxygen consumption at best is not an accurate measure of the organic content of a water, and it gives such uncertain results, that isolated determinations are of very little value. It is only when a water supply is to be examined repeatedly that the determination becomes very useful."

The *total solids,* although almost always included in sanitary water analysis, is not an important factor in determining the potability of water, as it varies widely among potable waters. It serves a better purpose in the ascertaining of the mineral quality of a water.

An idea of the importance of the determinations of some of the inorganic or mineral constituents of water may be seen from the following extracts from an article by Haywood (1902):

"Waters containing sulphates and chlorides in largely predominating amounts increase the activity of the liver, regulate the bowels, increase the flow of the urine, etc.

"Waters rich in sodium chloride are of value in cases of indigestion, since they increase the flow of the digestive fluids and prevent putrefactive changes in the intestines.

"Mineral waters which contain iron as one of the principal and most active constituents are principally used in cases of anaemia and general debility."

The results of chemical investigations on the water supplies in the Philippines are too limited to warrant definite conclusions or to enable one to establish certain standards by which to pass judgment on the fitness of various waters for certain purposes. The most comprehensive investigation on Philippine waters was undertaken by Cox, Heise, and Gana (1914). Their reports on water supplies

in the Philippines give the results of sanitary, mineral, and technical analyses of over eight hundred samples from different rivers, flowing streams, surface wells, deep or artesian wells, and springs from all over the Archipelago. But no definite conclusions were deduced or standards established. However, they stated that "the best water for human consumption is probably that which is as free as possible from organic matter and which contains only in relatively small amounts the normal mineral ingredients of natural water. The amount of mineral matter may generally, however, be varied within wide limits without producing marked physiologic effects. Water which is well aërated and the mineral content of which is below 300 parts per million is generally considered to have the best taste. Water which contains more than about 1,000 parts per million of mineral matter in solution is liable to prove laxative or to have an exceptional taste, although many waters, notably the waters from mineral springs, often containing over 2,000 parts per million are used constantly without deleterious effects."

Heise (1915) issued a continuation of the work mentioned above which is almost as comprehensive as the first but established no standards for sanitary waters.

A bacteriological examination of the water supply of the College of Agriculture was made by De Jesus (1931). He reported that it was free from fecal pollution and pathogenic bacteria.

MATERIALS AND METHODS

In this study, samples of water were taken from (1) the main pipe leading into the reservior, (2) a faucet in the Agricultural Chemistry Laboratory, (3) the Berkefeld filter at the College Cooperative Store, (4) the artesian well near Molawin Hall, and (5) the artesian well near the ice plant of the Animal Husbandry Department. Five sets of samples were collected at different seasons covering a period of about one year and nine months or from April 6, 1931 to December 6, 1932. The dates of collection are shown in the tables of results.

The following were determined in the waters analyzed: color, free ammonia, albuminoid ammonia, total organic nitrogen, nitrite nitrogen, nitrate nitrogen, oxygen-consuming capacity, pH values, total solids, dissolved solids, loss on ignition, silica, ferric oxide, aluminum oxide, calcium oxide, magnesium oxide, sodium and potassium as chlorides, sulfates and chlorides.

The *Official and Tentative Methods of Analysis of the Association of Official Agricultural Chemists* (1925) and the *Technical*

Methods of Analysis by Griffin (1921) were followed for procedures of analysis. In the determination of the different forms of nitrogen where several standards and the use of several Nessler's tubes are called for in the direction, a modification was made by using one standard solution and a Duboscq colorimeter (Bausch and Lomb No. 1248) for comparison.

In the determination of pH values, the potentiometric and the colorimetric methods were used. The platinum-cobalt method of measuring color whose unit is that color produced by one part of platinum per million was followed.

RESULTS AND DISCUSSION

The results of the analyses which are expressed in parts per million, except those of pH values, are given in tables 1 and 2, which also contain for comparison data reported by Haywood (1902), Cox, Heise and Gana (1914) and Heise (1916).

Table 1 shows results of determinations of components that require analysis immediately after collection of the samples; namely, the color, the different forms of nitrogen, oxygen-consumed, and pH. It may be seen in this table that the color of pipe waters seems to vary with the climatic condition. It was found low during the dry season and high during the rainy season. On the other hand, the artesian waters behaved in the reverse order. Such a behavior of the pipe waters was due to the carrying of colored materials from the surface into the stream by rain water. In the case of artesian waters, it might be due to dilution.

Of the different forms of nitrogen, nitrite was the least in amount, free ammonia was next, and then followed the other three forms which were about the same in amount. The figures for these constituents are within the range of variation of the results of other work in the Islands and of those obtained from the United States. Haywood, (1902), writing about potable waters in the United States, stated that "in many deep wells that are known to be pure, the free ammonia often runs as high as 0.700 to 0.800 part per million, while the amount that is ordinarily present in pure water is seldom above 0.05 to 0.10 part per million." He considered this as due to the reduction of nitrates by such reducing agents as ferrous sulfide at the bottom of the well. "Albuminoid ammonia often runs rather high, say 0.20 to 0.40 part per million in streams which contain much living plant life, the water from which is not on that account objection-

able.—The accepted standard for American rivers, as proposed by the late Professor Leeds, is 0.003 part of nitrogen as nitrite per million."

Most artesian waters from different parts of the Islands have the free ammonia and the albuminoid ammonia contents each below 1 part per million. Some waters, however, are high in free ammonia content, like the Iloilo waters (.041 to 22.6 parts per million of nitrogen as free ammonia) as reported by Cox, Heise and Gana (1914). According to these authors, these waters "probably owe their abnormal ammonia content to the peculiar nature of the strata through which they pass. According to W. E. Pratt of the Bureau of Science: 'the wells at Iloilo are sunk through estuarine deposits which are high in organic matter resulting both from plant and animal remains in the sediment themselves and from included remains of organisms that lived in the salt or brackish water in which the beds were laid down'."

The oxygen consumed by pipe waters varied from 1.7 to 10.45 parts per million and by artesian waters from 0.0 to .575 part per million. These figures show that the artesian waters have less oxidizable matter than the surface or pipe waters. Filtration through a Berkefeld filter decreases the oxidizable matter content as evidenced by the decrease of oxygen consumed.

The pH values of the different College waters were very nearly constant, around 7.00. The pipe waters varied from 6.42 to 7.74, the water from the artesian well near Molawin Hall, from 6.50 to 6.99, and the water from the artesian well in the Animal Husbandry Department, from 6.85 to 7.13 in pH.

Results of the inorganic determinations are shown in table 2. As may be seen in the table, the total solids of pipe waters varied from 151 to 214 parts per million and for artesian waters it is from 280 to 320 parts per million. These figures approach those reported by Heise (1916) for Manila water (153-220 p. p. m.) but are much lower than those reported for Los Baños artesian water (794.4 p. p. m.) by Cox, Heise and Gana (1914).

No appreciable difference was noted in dissolved solids in the different seasons especially for the Berkefeld-filtered water. This substantiates the findings of Bliss, who (cited by Cox, Heise and Gana) "pointed out that variations in seasons appear to have surprisingly little effect on the chemical constituents of surface water. The bacterial count often shows enormous increase after a heavy

shower. The amount of insoluble suspended matter increases appreciably in rainy weather, and the oxygen-consuming capacity appears to do same."

The loss on ignition was more for artesian waters than for pipe waters. The loss on ignition subtracted from the total solids gives the approximate amount of mineral matter. Because the volatile matter in the artesian waters was mostly bicarbonate, or carbonate (as tested), we may even assume the total solids to represent approximately the mineral constituents in these waters. From table 2, we can see then that the mineral contents of the artesian waters were around 300 parts per million, which is the optimum amount for potable waters as recommended by Cox, Heise and Gana (1914).

Examining the inorganic constituents determined, it will be observed that SiO_2 is more than any of the other components, CaO, and combined KCl and NaCl come next, $SO_4^{=}$ and Cl^- follow, and Fe_2O_3 and MgO are about the least.

The artesian waters had generally higher SiO_2, CaO, combined KCl and NaCl, and chloride contents than the pipe or stream water. In Fe_2O_3 and Al_2O_3, however, the tap water was richer. The MgO and the sulfate contents were very variable in the two kinds of waters for different seasons.

In SiO_2, Fe_2O_3 and Al_2O_3, and chloride contents, both pipe and artesian waters were higher than in the Manila water supply. In CaO, MgO, combined KCl and NaCl, and sulfate contents, the College of Agriculture pipe water had about the same range of variation as the Manila water supply. In all the inorganic constituents determined, except in Fe_2O_3-Al_2O_3, the Los Baños spring water (at Isuan Factory, as analyzed by Cox, Heise and Gana, 1914) had higher contents than either the pipe or the artesian waters of the College.

SUMMARY

1. The chemical analysis of the water supply of the College of Agriculture at different seasons covering a period from April 6, 1931 to December 6, 1932 were made.

2. The color of pipe waters was more intense during the rainy season than it was during the dry, whereas the artesian waters behaved in the reverse order. In all seasons the pipe waters were more deeply colored than the artesian waters.

3. The free and albuminoid ammonia and the total organic nitrogen of the surface or pipe waters were found to be more during the first part of the rainy season than at other times. The surface

or pipe waters had generally higher albuminoid ammonia and total organic nitrogen contents than the artesian water at any season of the year.

4. Except in one instance, the artesian waters analyzed contained very little or traces of oxidizable matter.

5. In pH the pipe or surface waters varied from 6.42 to 7.74 and the artesian waters from 6.50 to 7.13.

6. Solids, (in solution) which consisted mainly of silica, calcium, sodium, potassium, sulfates, chlorides, iron, aluminum and magnesium in solution in the waters examined, seemed not much affected by changes in weather conditions.

7. Basing conclusions on the chemical analysis, especially on the total organic nitrogen content, the oxygen-consuming capacity and the mineral contents, the artesian waters of the College of Agriculture are more potable than its pipe or stream waters.

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TABLE 1

The organic constituents, colors and pH of waters analyzed

DATE OF COLLECTION OF SAMPLES AND WEATHER CONDITION	COLOR (Platinum-cobalt method)					FREE AMMONIA (In parts per million)				
	I [d]	II [e]	III [f]	IV [g]	V [h]	I	II	III	IV	V
April 6, 1931—Sunny, bright	22.50	22.50	19.25	17.82	19.79	.040	.046	.040	.024	.109
May 20, 1931—Sunny, bright	44.64	20.49	24.26	22.92	22.67	.020	.021	.019	.038	.038
July 8, 1931—Rainy, had rained for about a week	55.31	49.44	47.37	10.73	10.31	.121	.062	.052	.090	.057
Aug. 8, 1932—Heavy rain day before	125.88	69.48	48.86	7.85	7.97	.037	.030	.026	.048	.051
Dec. 6, 1932—Bright sunshine two previous days	19.40	20.00	1.00	0.70	0.60	.029	.053	.037	.076	.045
Manila water supply [a]						0.0 – 0.12 (N as free NH_3)				
U. S. Water [b]						Ordinary – .05 – .10; occasional – 0.8				
Los Baños spring water (at Isuan Factory) [c]										
Los Baños artesian water [c]						32.70 (N as free NH_3)				

DATE OF COLLECTION OF SAMPLES AND WEATHER CONDITION	ALBUMINOID NH_3 (In parts per million)					TOTAL ORGANIC NITROGEN (In parts per million)				
	I	II	III	IV	V	I	II	III	IV	V
April 6, 1931—Sunny, bright	.100	.061		.047	.016	.120	.113	.016	.108	.124
May 20, 1931—Sunny, bright	.225	.191	.129	.074	.020	.254	.263		.167	.145
July 8, 1931—Rainy, had rained for about a week	.400	.404	.102	.132	.182		.549	.360	.270	.348
Aug. 8, 1932—Heavy rain day before	.097	.067	.028	.022	.020	.202	.187	.195	.127	.155
Dec. 6, 1932—Bright sunshine two previous days	.107	.102	.082	.080	.050	.200		.160	.110	.060
Manila water supply [a]	.031 – 0.116									
U. S. Water [b]	0.2 – 0.4 (rather high; occasional)									
Los Baños spring water (at Isuan Factory) [c]										
Los Baños artesian water [c]	1.188 (N as albuminoid NH_3)									

[a] Heise, George, Philippine Jour. Sci. Vol. XI—1916.
[b] Haywood J. K., U. S. Dept. Agric. Yearbook 1902.
[c] Cox, Heise and Gana, Philippine Jour. Sci. Vol. IX—1914.
[d] I —Main pipe.
[e] II —Pipe in the laboratory (Chem. II).
[f] III—Berkefeld-filtered water (College Cooperative Co.).
[g] IV—Artesian well near Molawin Hall.
[h] V —Artesian well near Animal Husbandry Department.

TABLE 1 (Continued)

DATE OF COLLECTION OF SAMPLES AND WEATHER CONDITION	NITRITE NITROGEN (In parts per million)					NITRATE NITROGEN (In parts per million)				
	I	II	III	IV	V	I	II	III	IV	V
April 6, 1931—Sunny, bright	.007	.006	.007	.011	.022	.686	.597	.589	.626	1.527
May 20, 1931—Sunny, bright	.008	.008	.012	.013	.009	.115	.125		.728	.658
July 8, 1931—Rainy, had rained for about a week	.008	.008	.008	.005	.006	.118	.128	.120	.677	1.305
Aug. 8, 1932—Heavy rain day before	.007	.006	.008	.002	.003	2.170	.089	1.760	1.410	.750
Dec. 6, 1932—Bright sunshine two previous days	.002	.003	.003	.002	.002	0.100	.088	.085	.069	1.310
Manila water supply [a]								trace – 0.36		
U. S. Water [b]			.003							
Los Baños spring water (at Isuan Factory) [c]			trace					1.195		
Los Baños artesian water [c]			none					none		

DATE OF COLLECTION OF SAMPLES AND WEATHER CONDITION	O_2 CONSUMED (In parts per million)					pH				
	I	II	III	IV	V	I	II	III	IV	V
April 6, 1931—Sunny, bright	8.10	7.40	6.95	5.25	4.75	6.55	6.42	6.75	6.85	7.13
May 20, 1931—Sunny, bright	5.25	5.10	4.70	trace	trace	6.73	7.05	7.74	6.99	6.96
July 8, 1931—Rainy, had rained for about a week	10.45	10.28	trace	trace	trace	7.20	7.20	7.20	6.50	6.90
Aug. 8, 1932—Heavy rain day before	1.70	2.30	1.00	trace	trace	7.00	7.00	7.00	6.80	7.10
Dec. 6, 1932—Bright sunshine two previous days	1.05	.97	0.55	0.20	0.10	7.00	7.05	7.05	6.70	6.85
Manila water supply [a]			0.65 – 2.20							
U. S. Water [b]										
Los Baños spring water (at Isuan Factory) [c]										
Los Baños artesian water [c]										

[a] Heise, George, Philippine Jour. Sci. Vol. XI—1916.
[b] Haywood J. K., U. S. Dept. Agric. Yearbook 1902.
[c] Cox, Heise and Gana, Philippine Jour. Sci. Vol. IX—1914.

TABLE 2

The inorganic constituents of waters analyzed

(In parts per million)

DATE OF COLLECTION OF SAMPLES AND WEATHER CONDITION	TOTAL SOLIDS					DISSOLVED SOLIDS				
	I [d]	II [e]	III [f]	IV [g]	V [h]	I	II	III	IV	V
April 6, 1931—Sunny, bright	158	167		232	281	156	160	156	281	280
May 20, 1931—Sunny, bright	164	151	155	310	280	164	150	155	274	278
July 8, 1931—Rainy, had rained for about a week		160	122	292	285	163	159	122	288	284
Aug. 8, 1932—Heavy rain day before	214	183	155	320	310	200	172	155	301	300
Dec. 6, 1932—Bright sunshine two previous days	164	162	145	307	295	140	140	145	307	295
Manila water supply [a]	153 – 220									
U. S. Water [b]	went up to 686 – 1200									
Los Baños spring water (at Isuan Factory) [c]										
Los Baños artesian water [c]	794.4									

DATE OF COLLECTION OF SAMPLES AND WEATHER CONDITION	LOSS ON IGNITION					SILICA				
	I	II	III	IV	V	I	II	III	IV	V
April 6, 1931—Sunny, bright	22.0	28.8	26.0	62.0	62.8	82.5	83.3	68.5	84.9	59.9
May 20, 1931—Sunny, bright	58.0	40.0	40.0	75.0	44.0	95.0	90.5	82.5	122.0	117.0
July 8, 1931—Rainy, had rained for about a week	50.0	44.0	24.0	84.0	88.0	67.2	74.0	64.0	96.0	102.8
Aug. 8, 1932—Heavy rain day before	48.0	37.0	37.0	83.4	77.0	93.0	86.0	82.0	131.4	121.0
Dec. 6, 1932—Bright sunshine two previous days	5.0	4.0	1.0	14.0	53.0	85.0	87.0	77.0	128.0	129.0
Manila water supply [a]	16 – 46					23.7 – 44.7				
U. S. Water [b]										
Los Baños spring water (at Isuan Factory) [c]						161.4				
Los Baños artesian water [c]	38.4									

[a] Heise, George, Philippine Jour. Sci. Vol. XI—1916.
[b] Haywood J. K., U. S. Dept. Agric. Yearbook 1902.
[c] Cox, Heise and Gana, Philippine Jour. Sci. Vol. IX—1914.
[d] I —Main pipe.
[e] II —Pipe in the laboratory (Chem. II).
[f] III—Berkefeld-filtered water (College Cooperative Co.).
[g] IV—Artesian well near Molawin Hall.
[h] V —Artesian well near Animal Husbandry Department.

TABLE 2 (Continued)

DATE OF COLLECTION OF SAMPLES AND WEATHER CONDITION	$Fe_2O_3 - Al_2O_3$					Fe_2O_3				
	I	II	III	IV	V	I	II	III	IV	V
April 6, 1931—Sunny, bright	15.4	9.8	14.0	14.4	13.4	2.97	2.12	1.69	1.69	1.69
May 20, 1931—Sunny, bright	20.0	22.5	7.0	5.0	4.5	1.37	1.98	1.43	1.43	1.55
July 8, 1931—Rainy, had rained for about a week	16.8	28.8	6.8	8.5		2.60	5.20	1.19		0.71
Aug. 8, 1932—Heavy rain day before	32.0	29.0	15.0	10.0	8.0	9.53	5.72	0.17	0.37	0.56
Dec. 6, 1932—Bright sunshine two previous days	13.0	12.0	6.0	10.0	7.0	2.29	2.60	0.30	0.36	
Manila water supply[a]			1.7							
U. S. Water[b]										
Los Baños spring water (at Isuan Factory)[c]			1.25							
Los Baños artesian water[c]										

DATE OF COLLECTION OF SAMPLES AND WEATHER CONDITION	CaO					MgO				
	I	II	III	IV	V	I	II	III	IV	V
April 6, 1931—Sunny, bright	34.47	30.70	33.90	62.90	51.50	2.14	3.20	3.52	5.17	5.04
May 20, 1931—Sunny, bright	16.50	16.00	15.00	35.00	46.50	5.07	7.24	6.88	1.81	9.23
July 8, 1931—Rainy, had rained for about a week	34.40	24.80	22.90	51.00	48.00	10.40	5.80	2.10	7.80	9.30
Aug. 8, 1932—Heavy rain day before	18.60	15.60	12.00	52.00	62.00	5.20	2.20	2.30	11.70	8.20
Dec. 6, 1932—Bright sunshine two previous days	21.00	21.40	20.00	50.00	58.00	5.07	6.30	3.98	4.71	
Manila water supply[a]			16.4 – 31.2 (Ca)					5.4 – 6.5 (Mg)		
U. S. Water[b]										
Los Baños spring water (at Isuan Factory)[c]			90. 35 (Ca)					19.30 (Mg)		
Los Baños artesian water[c]										

[a] Heise, George, Philippine Jour. Sci. Vol. XI—1916.
[b] Haywood J. K., U. S. Dept. Agric. Yearbook 1902.
[c] Cox, Heise and Gana, Philippine Jour. Sci. Vol. IX—1914.

TABLE 2 (Continued)

DATE OF COLLECTION OF SAMPLES AND WEATHER CONDITION	KCl - NaCl					SO_4				
	I	II	III	IV	V	I	II	III	IV	V
April 6, 1931—Sunny, bright	35.0	30.0	30.0	46.0	52.0	22.50	20.70	17.30	20.50	26.40
May 20, 1931—Sunny, bright	40.0	38.0	40.0	43.0	52.0	23.55	23.96	34.66	33.83	32.60
July 8, 1931—Rainy, had rained for about a week	25.0	23.0	30.0	45.0	53.0	24.37	13.67	12.03	31.78	24.37
Aug. 8, 1932—Heavy rain day before	28.0	32.4	31.0	66.6	79.0	7.81	7.49	9.87	10.54	8.23
Dec. 6, 1932—Bright sunshine two previous days	45.0	50.0	52.0	66.0	68.0	14.40	13.99	13.58	11.19	9.46
Manila water supply [a]			10.3 – 14.6 (K & Na)					13.8 – 18.7		
U. S. Water [b]										
Los Baños spring water (at Isuan Factory) [c]			229.0 (K & Na)					26.99		
Los Baños artesian water [c]										

DATE OF COLLECTION OF SAMPLES AND WEATHER CONDITION	Cl				
	I	II	III	IV	V
April 6, 1931—Sunny, bright	9.03	9.03	9.03	15.80	13.60
May 20, 1931—Sunny, bright	7.80	8.19	7.80	10.02	8.38
July 8, 1931—Rainy, had rained for about a week	17.15	17.43	9.82	15.80	12.62
Aug. 8, 1932—Heavy rain day before	10.01	9.63	9.63	14.45	14.45
Dec. 6, 1932—Bright sunshine two previous days	6.20	5.80	5.50	9.90	6.70
Manila water supply [a]			2.1 – 4.4		
U. S. Water [b]					
Los Baños spring water (at Isuan Factory) [c]			367.5		
Los Baños artesian water [c]			24.46		

[a] Heise, George, Philippine Jour. Sci. Vol. XI—1916.
[b] Haywood J. K., U. S. Dept. Agric. Yearbook 1902.
[c] Cox, Heise and Gana, Philippine Jour. Sci. Vol. IX—1914.

PROTEIN SUPPLEMENTS IN POULTRY RATIONS: II. COMPARATIVE EFFECTS OF SHRIMP MEAL, MEAT SCRAPS, TANKAGE, AND FISH MEAL AS SUPPLEMENTS IN RATIONS FOR LAYING HENS [1]

ALFREDO A. FRANCISCO, GREGORIO S. CHAN, AND F. M. FRONDA

WITH TWO CHARTS

In a previous paper (1933) it was shown that shrimp meal, fish meal, meat scraps and tankage rank in the order given in their efficiency as supplements in rations for growing chickens. The present paper reports the results obtained in a study of the comparative effects of these protein feeds as supplements in rations for laying hens. This experiment was conducted in the Department of Animal Husbandry, College of Agriculture, from September 1, 1931 to August 31, 1932, covering a period of 366 days.

REVIEW OF LITERATURE

Kempster (1930) made a study of the influence of various protein concentrates as supplements in rations for egg production and found that concentrates of animal origin as dried butter-milk, meat scraps, tankage, and fish meal rank in the order named in value in influencing egg production. He pointed out that cost is an important factor in selecting a protein concentrate and that the extra eggs laid by the flock that was fed dried butter-milk would not pay for the extra cost of the ration, whereas the lot fed with meat scraps would. Kempster further found that larger eggs were produced by hens fed with dried butter-milk, followed by meat scraps and tankage gave the third largest. The hens fed with butter-milk produced the highest percentage of fertile eggs; meat scraps, fish meal, and tankage lots followed in the order named. As to hatchability of eggs, the lots fed with butter-milk, fish meal, and meat scraps produced more hatchable eggs than the lot fed with tankage.

Lewis (1913) observed that the addition in rations of animal protein supplement, as meat scraps, materially increased the effi-

[1] The data presented in this paper were taken from the theses presented by the two senior authors for graduation, 1933, with the degree of Bachelor of Agriculture and of Bachelor of Science in Agriculture from the College of Agriculture, Nos. 374 and 375; Experiment Station contribution No. 942. Prepared under the direction of Dr. F. M. Fronda.

ciency of a ration both for egg production and for growth. Dougherty (1914) concluded, as a result of one year's investigation, that to secure the best results animal proteins should be fed to laying hens. He further stated that a good grade of fish scraps gave as good results as commercial meat scraps, and when properly fed did not in any way taint the eggs laid.

Philips (1915) made a study of the value of meat scraps, fish meal, and skim milk in rations for laying hens and observed that the addition of these protein concentrates increased egg production and consequently increased profits. He found that pullets fed with skim milk and meat scraps produced more hatchable eggs than the lot fed with fish scraps, and that pullets that received neither meat scraps, fish scraps nor skim milk were kept at a loss. In another study along this line, Philips (1918) found that the egg production averaged 140.2 per pullet for the lot fed with skim milk; 135.9, when fed meat scraps; and 61.2 on no-meat-food ration. He also found that pullets fed neither skim milk nor meat scraps produced the highest percentage of fertile eggs, followed by the birds fed with meat scraps and the lot fed with skim milk.

Philips (1919) in his feeding experiments with Leghorns observed that the presence of animal proteins in a ration increased the efficiency of the feeds given; that the pullets fed with meat scraps and tankage produced more eggs than the ones that were fed with proteins of vegetable origin. He further found that increasing the grain did not influence the fertility or hatchability of the eggs produced by the lots fed with protein supplements of both vegetal and animal origin.

Lee (1921) reported that a ration supplemented with fish scraps produced a larger number of eggs than the lot fed with meat scraps. He also observed that tankage as a supplement in laying ration produced as good a result as meat scraps. Guldin and Knandel (1922) also made a study on the feeding of laying hens and from the results of their observations they concluded that one of the three essentials for the successful feeding of laying hens is some high protein feed, such as meat scraps, milk or tankage, and this should always be used as part of the laying rations during the whole year. The use of such protein concentrates will increase the egg production and yield more profit per hen.

Kaupp and Dearstyne (1923), found in their feeding experiments with poultry that 20 per cent fish meal in the ration for egg production may be used to replace meat meal, and that this protein feed does not impart a fishy flavor in the eggs produced. Elford

(1924) observed that 20 per cent fish meal in the mash produced practically the same results in egg production as other mashes containing 20 per cent beef scraps and tankage.

Kempster (1924) reported that the use of meat scraps, tankage, sour skim milk and dried butter-milk resulted in higher egg production than when no animal proteins were used; that feeding meat scraps, tankage, or milk products reduced nearly one-half the amount of feed required to produce a dozen eggs. He further concluded that mashes having 15 per cent or more of meat scraps or tankage gave more satisfactory results than when smaller amounts were used.

Serrano (1928) found that the ration containing dried shrimps produced better results than when copra meal was used as source of protein. Fronda (1929) made a study of the effects of dried shrimps and fish meal as supplements in rations for egg production and reported that these feeds produced satisfactory results when they constituted five per cent of the ration. He further observed that the addition of protein supplements in the rations lowered the mortality of the birds.

Henry and Morrison (1929) pointed out that meat meal is the most widely used protein supplement for poultry, though in dairy districts it is replaced by skim milk and butter-milk. These authors further stated that tankage and fish scraps may also be used in place of meat scraps as protein feeds for poultry in order to obtain higher egg production.

Morgan (1930) comparing fish meal and meat scraps reported that, on the basis of egg production, fish meal is equal in value to meat scraps, but that fish meal reduced the hatchability of the eggs.

MATERIALS AND METHODS

The flock. One hundred and eight Los Baños Cantonese pullets were divided into four lots of 27 pullets each. Two roosters of the same breed were placed in each pen. The pullets used were just starting to lay and were all of practically the same age. They were housed in four pens of uniform size with two grassy yards adjoining each pen. The birds were trapnested throughout the year.

Care and management. The pullets in all the lots were hand-fed with grain and self-fed with mash. The ration consisted of grain and mash as near as possible in the proportion of 1:1. The grain consisted of 5 parts by weight of cracked yellow corn and 5 parts palay. The mash used consisted of 4 parts by weight of fine

rice bran, 3 parts copra meal, 1 part corn meal and 2 parts of the supplements.[2] The following table shows by weight all the mash ingredients of the rations given to the different lots.

INGREDIENTS	LOT 1	LOT 2	LOT 3	LOT 4
	parts	*parts*	*parts*	*parts*
Rice bran	4	4	4	4
Copra meal	3	3	3	3
Corn meal	1	1	1	1
Shrimp meal	2	—	—	—
Fish meal	—	2	—	—
Tankage	—	—	2	—
Meat scraps	—	—	—	2
Total	10	10	10	10

The prices per kilogram of the feeds used were based on the current prices in the local market and were as follows:

Corn	₱0.050	per kgm.
Rice bran	0.044	" "
Copra meal	0.038	" "
Palay	0.047	" "
Shrimp meal	0.121	" "
Fish meal	0.165	" "
Tankage	0.247	" "
Meat scraps	0.267	" "

The cost of the different rations was based upon these prices. The cost of grain was ₱0.048 per kgm. in all the lots. The mash supplemented with shrimp meal cost ₱0.058 per kilogram, that with fish meal, ₱0.067; that with tankage, ₱0.083; and that with meat scraps, ₱0.087.

Records kept. The pullets were all trapnested and records of egg production were kept throughout the year. The amounts of feed consumed were noted and recorded at the end of the month. All the birds in the four lots were weighed at the beginning of the experiment and once a month thereafter making a total of thirteen weighings. Three incubation tests were made and upon these the hatchability results were based. Mortality records of the birds were kept.

[2] For the analysis of the supplements used, *see* FRONDA, F. M., ACELO C. BADELLES, AND JUAN S. PADILLA, 1933. Protein supplements in poultry rations: I. Comparative studies of the effects of shrimp meal, meat scraps, tankage and fish meal as supplements in rations for growing chickens. The Philippine Agriculturist 22: 582-598. *Charts 1-2.*

RESULTS AND DISCUSSIONS

Egg production and cost. Table 1 gives the monthly percentage production of the four lots. Table 1 is graphically represented in chart 1. Referring to this table and to chart 1, it will be observed that egg production in lot 1, shrimp meal lot, was the highest; lot 4, meat scraps lot, followed a close second; lot 2, fish meal lot, was third; and lot 3, tankage lot, was last. Lot 1, the shrimp meal lot, gave its highest production in February, with a total of 349 eggs or a percent-

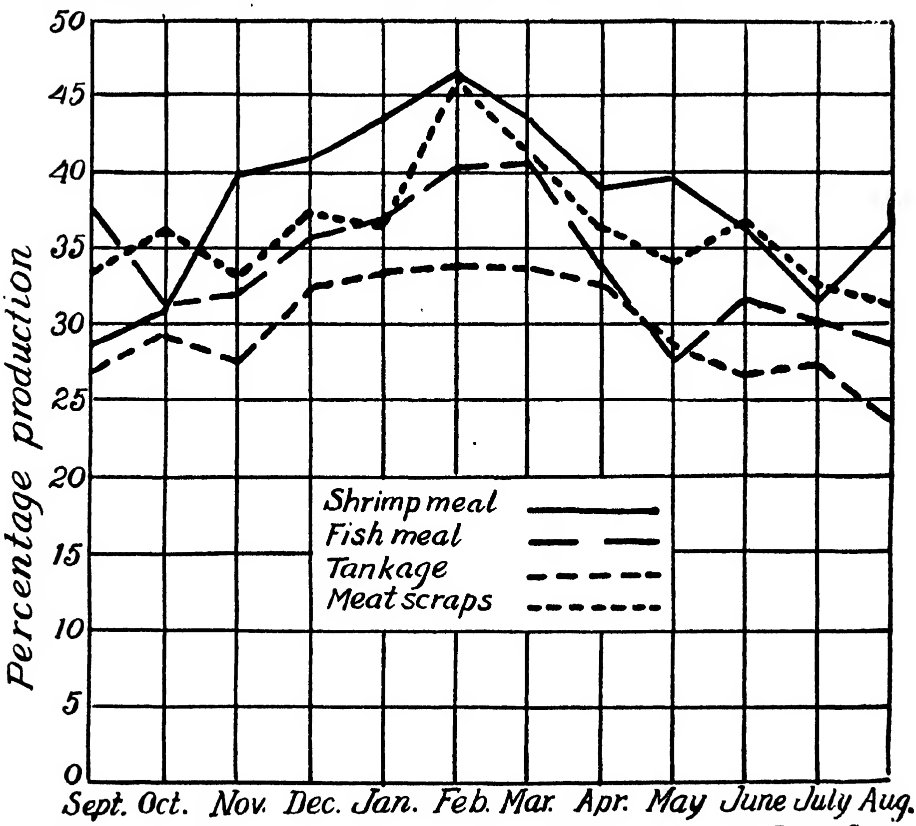

Chart 1.—Showing the percentage production of the four lots of Los Baños Cantonese pullets that were given the different supplements studied.

age production of 46.3. Its lowest production was in the first month of the experiment with only 28.3 per cent. This lot produced a total of 3,572 eggs, or 37.9 per cent. This means an average production of 139.0 eggs per bird. Lot 2, the fish meal lot, gave its highest production in March, with a total of 340 eggs or a percentage production of 40.6. Its lowest production was in May with only 27.5 per cent. This lot produced a total of 3,346 eggs, or 33.9 per cent. This means

an average production of 124.0 eggs per bird. Lot 3, the tankage lot, produced the lowest number of eggs of the four supplements tried. February, 1932 was the highest month in production in this lot with 33.8 per cent, and August was the lowest with a monthly production of only 23.5 per cent. The tankage fed lot had a total production for the year of 2,792 eggs, or 29.6 per cent. This means an average of only 108.3 per bird. The meat scraps lot, lot 4, ranked second to lot 1 in egg production. The total number of eggs laid by this lot was 3,367. This lot had an average yearly production of 36.2 per cent or an average production of 132.5 eggs per bird. The highest egg production was recorded in the month of February, 1932 with 345 eggs or an average of 45.8 per cent for the month. The lowest month in production for this lot was August, 1932 with 222 eggs or an average of 31.1 per cent.

When computed on the basis of the birds that actually completed the year, excluding those that died, it was found that the shrimp meal lot, lot 1, had an average yearly production of 37.9 per cent or an average of 139.0 eggs per bird; the fish meal lot, lot 2, 33.9 per cent or an average of 124.0 eggs per bird; the tankage lot, lot 3, 29.6 per cent or an average of 108.0 eggs per bird; and lot 4, meat scraps lot, was 36.1 per cent or 131.8 eggs per bird. These figures showed no marked difference from those reported in the preceding paragraph on the actual egg production per lot.

Feed consumption and cost. Table 2 shows the actual yearly consumption of grain and mash of the four lots. By reference to table 2, it may be seen that the shrimp meal lot consumed 752.3 kgm. of feeds in the whole period or an average of 28.0 kgm. per bird; the fish meal lot, lot 2, 731.3 kgm. of feeds for the period or an average of 27.1 kgm. per bird; lot 3, the tankage lot, 694.5 kgm. or an average of 27.0 kgm. feed per bird; and the meat scraps lot, lot 4, consumed 692.4 kgm. or an average of 27.3 kgm. per bird. Thus, the amounts consumed by the four lots were practically the same.

Table 2 also shows the relative cost of feeds consumed and the total number of eggs produced by the various lots. The eggs laid were classified as standards, those weighing 45 grams or more, and undergrades, those that weighed less than 45 grams. Standard eggs were valued at four centavos each and the undergrades at three centavos.

On these values the returns from each lot were based. The shrimp meal lot produced 864 standard eggs and 2,708 undergrades, giving a total value of ₱115.80. The cost of feeds consumed by this lot was ₱39.76, thus giving a return of ₱76.04 over the cost of feeds.

The fish meal lot produced 925 standard eggs and 2,421 undergrades, giving a total value of ₱109.63. The cost of feeds consumed by this lot was ₱41.99, giving a return of ₱67.64 over the cost of feeds. The tankage lot produced 519 standard eggs and 2,273 undergrades, with a value of ₱88.95. The feeds consumed cost ₱45.01, giving a return of ₱43.94 over the cost of feeds. The meat scraps lot laid 887 standard eggs and 2,480 undergrades, valued at ₱109.88. The cost of feeds consumed by lot 4 was ₱46.34, giving a return over the cost of feeds of ₱63.54, which was ₱4.10 less than that obtained from the fish meal lot. This difference between these two lots was due to the high cost of meat scraps. These figures show that the cost of the feeds used is a very important factor in computing rations for laying hens as it greatly affects the profits from the sale of eggs as well as the cost of producing them.

The amount of feeds necessary to produce a dozen eggs was also determined. From the figures obtained it may be stated that lot 1, the shrimp meal lot, was given the most economical ration. Lot 2, the fish meal lot, was second in the economy of ration; lot 4, the meat scraps lot followed a close third; and lot 3, the lot fed with tankage produced the most expensive eggs. Lot 1, the shrimp meal lot, consumed the greatest amount of feeds, yet it was the cheapest in terms of pesos and centavos, or in cost of feeds consumed.

Effects of feeds on the weight of birds. Table 3 gives the number and average weights of the pullets at the beginning and at the close of the experiment. At the beginning of the experiment these pullets had not reached their maximum weights, hence they increased in weight during the progress of the work. Fronda (1929) observed that the addition of any protein supplement of animal origin tends to increase the weight of the birds. The fish meal lot attained an average increase of 59.3 grams, or only 4.5 per cent, by the end of the experiment. The lot that was fed with shrimp meal, lot 1, had the largest increase in weight at the close of the study. This lot attained an average increase of 199.8 grams, or 15.9 per cent. Lot 3 was second in the increase in weight, attaining an average increase of 108.3 grams or 8.2 per cent. The meat scraps lot, lot 4, had an average increase of 67.1 grams or 5.0 per cent, which was practically the same as the fish meal lot, lot 2. The appearance of the birds in the four lots was about the same throughout the duration of this study.

Mortality of the pullets. By referring again to table 3, it may be seen that the percentages of mortality from the different lots during the whole period of the experiment were markedly different.

The mortality in lots 1 and 3 was 7.4 per cent each; in lot 4 it was 14.8 per cent. None of the birds in the fish meal lot, lot 2, died. With the exception of one pullet that was a little out of condition, all the birds in this lot were vigorous and healthy at the end of this study. One bird from the shrimp meal lot, lot 1, died of "egg bound" and another one of roup. Three birds from the meat scraps lot, lot 4, died. When they were examined, broken eggs were found inside the reproductive tract of these birds. The two pullets that died in the tankage lot, lot 3, succumbed to ocular roup.

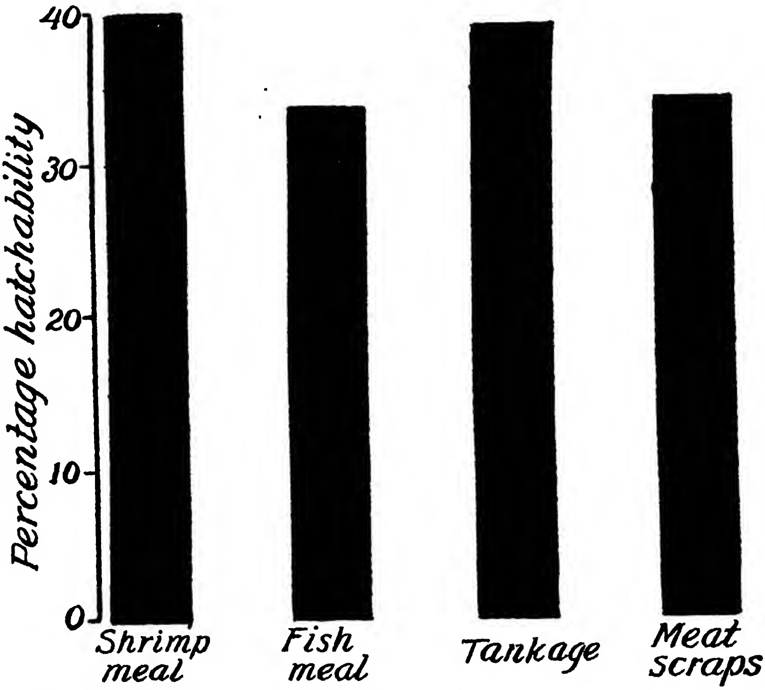

Chart 2.—Showing the comparative hatchability of the eggs produced by the four lots of Los Baños Cantonese pullets that were given the different supplements studied.

Effects on hatchability of eggs. All the eggs for incubation purposes were collected, weighed and set at the same time in an incubator. The hatching results based upon about 250 eggs set from each of the four lots are graphically shown in chart 2 where it will be seen that the shrimp meal lot produced the most hatchable eggs, 39.7 per cent; lot 3, the tankage lot, produced 38.8 per cent, being the second highest. The fish meal, lot 2, and the meat scraps, lot 4, were practically the same in percentage of hatchability, 33.8 and 34.2 each, respectively. There was a tendency for the eggs produced

by the lots fed with shrimp meal and tankage to be more hatchable than the eggs laid by the meat scraps and the fish meal lots. Morgan (1930) reported that the hatchability of eggs following the use of fish meal was less than where meat scraps were used, thus supporting the results obtained in the present study. However, further studies along this line will be necessary to make possible the drawing of a more definite conclusion.

SUMMARY AND CONCLUSIONS

The results of a study on the effects of shrimp meal, fish meal, tankage, and meat scraps as supplements in rations for egg production are given in this paper. These may be summarized as follows:

1. In the order of total number of eggs produced and average annual production the lots stood as follows: shrimp meal lot, first; meat scraps lot, second; fish meal lot, third; and tankage lot, fourth. The shrimp meal lot had an average production of 139.0 eggs per bird; the meat scraps lot, 132.5 eggs; the fish meal lot, 124.0 eggs, and the tankage lot, 108.3 eggs.

2. The value of the eggs produced was ₱115.80 for shrimp meal lot; ₱109.88 for the meat scraps lot; ₱109.63 for the fish meal lot; and ₱88.95 for the tankage lot.

3. To produce a dozen eggs it cost, on an average, ₱0.134 for feed in the shrimp meal lot; ₱0.151 in the fish meal lot; ₱0.165 in the meat scraps lot; and ₱0.193 in the tankage lot.

4. The returns above the cost of feed, with 27 birds in each lot, was ₱76.04 in the shrimp meal lot; ₱67.64 in the fish meal lot; ₱63.54 in the meat scraps lot; and ₱43.94 in the tankage lot.

5. Of the supplements used, shrimp meal was the cheapest; fish meal, the second, and meat scraps, the third. The tankage was the most expensive.

6. When used as supplement to laying ration in the amount of twenty per cent of the mash, fish meal and meat scraps were about equal in value, and better than tankage. But shrimp meal was the best. There was a tendency for tankage to be less palatable than the other supplements used.

7. The shrimp meal lot gained 15.9 per cent in weight; the tankage lot, 8.1 per cent; the fish meal and meat scraps lots produced practically the same percentage of gain in weight with 4.4 and 4.2, respectively.

8. There was no mortality registered in the lot fed with fish meal. The lots fed with shrimp meal and tankage had a mortality of 7.4 per cent each; the meat scraps lot, 14.8 per cent.

9. There was a tendency for the eggs produced by the lots fed with shrimp meal and tankage to be more hatchable than the eggs laid by the fish meal and the meat scraps lots.

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TABLE 1

Showing the monthly percentage of egg production of each lot

MONTHS	LOT 1 (SHRIMP MEAL)	LOT 2 (FISH MEAL)	LOT 3 (TANKAGE)	LOT 4 (MEAT SCRAPS)
	per cent	*per cent*	*per cent*	*per cent*
September, 1931	28.3	37.7	26.9	33.5
October, "	30.9	31.2	29.2	36.2
November, "	39.9	32.0	27.7	33.2
December, "	40.9	35.8	32.2	37.5
January, 1932	43.5	37.1	33.3	36.4
February, "	46.3	40.2	33.8	45.8
March, "	43.7	40.6	33.6	41.4
April, "	38.8	33.8	32.7	36.2
May, "	39.6	27.6	28.5	34.0
June, "	36.1	31.9	26.8	36.5
July, "	31.2	30.1	27.0	32.5
August, "	36.1	28.8	23.6	31.1
Average	37.9	33.9	29.6	36.2

TABLE 2

Showing the relative cost of feeds used and eggs produced

	LOT 1 (SHRIMP MEAL)		LOT 2 (FISH MEAL)		LOT 3 (TANKAGE)		LOT 4 (MEAT SCRAPS)	
	Amount	Value	Amount	Value	Amount	Value	Amount	Value
		pesos		*pesos*		*pesos*		*pesos*
Amount of grain consumed, kgm.	386.9	18.57	369.1	17.72	360.9	17.32	356.4	17.11
Amount of mash consumed, kgm.	365.4	21.19	362.2	24.27	333.6	27.69	336.0	29.23
Total feed consumed, kgm.	752.3	39.76	731.3	41.99	694.5	45.01	692.4	46.34
Av. feed consumed per bird, kgm.	28.0	1.84	27.1	1.49	27.0	1.70	27.3	1.78
Standard eggs laid @ 4 ¢	864	34.56	925	37.00	519	20.76	887	35.48
Undergrade eggs laid @ 3 ¢	2,708	81.24	2,421	72.63	2,273	68.19	2,480	74.40
Total eggs laid	3,572	115.80	3,346	109.63	2,792	88.95	3,367	109.88
Kgm. of feed to produce one dozen eggs	2.53	0.134	2.62	0.151	2.98	0.193	2.47	0.165
Returns above cost of feeds	₱76.04		₱67.64		₱43.94		₱63.54	

TABLE 3

Showing the average weight of pullets at the beginning and at the close of the experiment and the percentages of mortality

	LOT 1 (SHRIMP MEAL)	LOT 2 (FISH MEAL)	LOT 3 (TANKAGE)	LOT 4 (MEAT SCRAPS)
Number of birds at the beginning, September 1, 1931	27	27	27	27
Average weight in grams of birds at the beginning	1,260.2	1,326.8	1,327.7	1,348.1
Number of birds at the close, August 31, 1932	25	27	25	23
Average weight in grams at the close	1,460.0	1,386.1	1,436.0	1,415.2
Average gain in weight in grams per bird	199.8	59.3	108.3	67.1
Percentage of gain in weight per bird	15.9	4.4	8.1	4.2
Percentage of mortality during the year	7.4	0	7.4	14.8

ABSTRACT[1]

A comparative study of two kinds of manimanihan, Alysicarpus nummularifolius (Linn.) D. C. and Desmodium capitatum (Burm. f.) as forage crops. PERICO Y. ARCEDO. (*Thesis presented for graduation with the degree of Bachelor of Science in Agriculture, 1933, from the College of Agriculture No. 376; Experiment Station contribution No. 943.*)—The object of this study was to determine the comparative value of two kinds of manimanihan, *Desmodium capitatum* and *Alysicarpus nummularifolius* as forage crops.

The work was begun in April, 1931 and closed January 12, 1933. The culture of this study was carried in the experimental field of the Department of Agronomy, College of Agriculture; the palatability tests were conducted in the Animal Husbandry Department.

The *Alysicarpus nummularifolius* used was gathered at Muñoz, Nueva Ecija and the *Desmodium capitatum* was collected from the pasture land of the Department of Agronomy. The land used was plowed and harrowed three times. The seeds used were planted directly in the field. The weight of the harvested forage was recorded and then the fresh soilage was taken to the Animal Husbandry Department for palatability tests. Palatability tests on hay made from these forages were also carried. Philippine horses were used in the palatability tests. The animals were weighed at the beginning of the experiment and their weight was taken every five days thereafter.

The author made observations on the following points: tests on germination, growth, palatability, curing quality of hay, soiling quality, and the production per hectare. The results obtained and conclusions are as follows:

1. The percentage of germination was 43.35 for *A. nummularifolius* and 44.85 for *D. capitatum*.

2. The average weekly growth for the first culture was 6.05 cm. for *A. nummularifolius* and 4.72 cm. for *D. capitatum*. In the second culture the former made better growth than the latter.

3. The palatability of the fresh and cured materials was higher in *A. nummularifolius* than in *D. capitatum*. It took a horse a longer time to consume 1.2 kgm. of *D. capitatum* than 3.9 kgm. of *A.*

[1] Abstract prepared as a part of the required theme work in English 3a, College of Agriculture.

nummularifolius. The average length of time required to consume one kgm. of fresh *A. nummularifolius* was 1.57 hours and *D. capitatum,* 5.10 hours.

4. In the first culture, the average production per hectare of *A. nummularifolius* was 10,016.67 kgm.; of *D. capitatum*, 6,168.67 kgm. The average production of hay per hectare of *A. nummularifolius* was 4,372.24 kgm., of *D. capitatum*, 2,785.17 kgm.

5. *A. nummularifolius* had better curing quality than *D. capitatum.*

6. The animals did not relish the hay made from either variety.

7. *A. nummularifolius* was better for soiling purposes than *D. capitatum.*

The author suggests that the cultivation of *Alysicarpus nummularifolius* (Linn.) D. C. be given another trial for soiling purposes.

—*Abstract by Porfirio V. Barlaan.*

CURRENT NOTES

As an example of the value of research and how the stoppage of it can bring disastrous results, *Industrial and Engineering Chemistry* cites the case of the cocoa industry in Ecuador. The depression hit there earlier than it did in the United States and an economic program stopped research.

Fifteen years ago Ecuador, then one of the principal exporters of cocoa, was disturbed by a disease attacking the pods from which the chocolate is manufactured. Although the value of the cacao exceeded that of all the rest of the country's exports combined, there had been no serious attempt to protect it against pests. Studies of this disease were begun, but with the depression of 1921 most of the research work was discontinued; in a few years the uncontrolled spread of the disease forced the abandonment of one of the best of the cacao varieties.

The lapse in the cacao research work proved doubly inopportune. Just at this time a witches-broom disease became conspicuous in one of the important cacao districts. In four years the yield in this district declined to less than one-fortieth of its original volume and the jungle has taken many of the plantations. The disease spread to other parts of the country and the cacao exports of Ecuador during a period of increasing world consumption dropped by 1930 to less than half their former volume. Resumption of inves-

tigative effort has shown that resistant varieties can be produced and the industry may be re-established, but too late to save the existing plantations in the regions most affected by the disease.

The Tropical Agriculturist, September, 1933

When some hens were recently taken a journey by aeroplane in Canada, they suffered from severe air-sickness.

The New Zealand Dairyman, March 20, 1933

In an effort to increase sugar consumption in Mexico, the producers and distributors have enlisted the aid of wireless. "The Sweet Hour," as the radio programme is called, disseminates educational propaganda as to the dietetic value of sugar, and is accompanied by instrumental and vocal music. The programme is given twice a week. Per capita consumption in Mexico last year was something under 25 lbs.

The Australian Sugar Journal, March 9, 1933

Sold out in a day
Birth of a new trade

The first consignment of Indian mangosteens to be placed on the London market was sold out in 24 hours, so great was the demand for this newcomer to Covent Garden. The consignment, which consisted of one thousand fruits, was sent from Burma to the Empire Marketing Board as an experimental shipment, and arrived in such good condition that a decision to market most of it as an experiment was made.

The mangosteens were handed over to Messrs. Poupart's, a big Covent Garden firm of fruiterers, and were sold at several West-end stores at 4d. each. There was a rush to buy them, and the fruit was all sold by the same evening. A large number of orders have already been received for the next consignment, which is due in about three weeks' time.

This is the third successive season in which the Empire Marketing Board had handled experimental shipments of mangosteens. The fruit is greeted on arrival by the Board's scientific officers, who have made various recommendations for the improvement of transport and packing. Partly as a result, a successful method of carrying this extremely delicate fruit to London in cool storage has been worked out, and it is hoped that a new trade in mangosteens will shortly be

developed. *Extract from Agriculture and Live Stock in India,* November, 1932. Reprinted in *The Journal of the Jamaica Agricultural Society,* August, 1933.

Most of the defects in dairy produce are due to dirty methods in the milking shed and neglect of cooling the milk or cream. Some people have the idea that a strainer will remove any dirt which enters the milk. This is quite wrong, because much of the dirt is dissolved, and the finest strainer cannot catch the bacteria which are responsible for most of the defects in butter and cheese. The only satisfactory method is to prevent dirt from entering the milk. This can be done by taking proper care of the dairy utensils.

Every dairy should be supplied with proper conveniences for cleaning the various utensils. Brushes are much better than cloths. They remove dirt from the corners, and can themselves be kept clean more easily than cloths.

Nothing provides a better breeding place for germs than a dirty cloth. Cans should be washed in tepid water before they are scalded, this is because hot water causes the albumen to coagulate and form a scum, which is difficult to remove. After washing in tepid water, scrub the cans in hot water containing soda; then scald in clean boiling water....

They should not be dried with a cloth, the water will be evaporated quickly by the heat of the metal, if they have been properly scalded.

The Journal of the Department of Agriculture of South Australia, September, 1933

The establishment of the tung oil industry in the United States has been so successful during the last few years that it is now being expanded on a much larger scale. Seeds of the tree were first introduced into America through the United States Department of Agriculture in 1905 but extensive plantings were not made until some eight years ago in the Southern States where 25,000 acres of land have now been devoted to the industry. The oil, apart from being a valuable ingredient of varnishes and varnish paints, is now employed in the manufacture of insulating compounds, brake linings, linoleum, water-proofing fabrics, as a binder for wall board and plastic synthetic lumber, primers, synthetic resins, battery jar compounds and aeroplane tubing fillers.

Tropical Agriculture September, 1933

COLLEGE AND ALUMNI NOTES

Dr. Choji Ito, professor of agricultural economics in Kyushu Imperial University Japan was a Campus visitor in November. On one day with Dean Gonzales and Professor Velmonte he went on a motor trip through the farming regions in Laguna and Batangas provinces, stopping in San Pablo for a visit to the Franklin Baker Dessicated Coconut Factory. On the Campus, Doctor Ito gave the major portion of his time to the Agronomy and Economic departments.

In the evening of November 23 the Los Baños Biological Club celebrated the tenth year of its existence with a large faculty and student dinner in Molawin Hall. With Dr. F. O. Santos as toastmaster the short after dinner talks by Dr. E. B. Copeland, Dean Gonzales, Mrs. Gonzales, Mr. Bousman and heads of the departments were in the main more laugh- than thought-provoking, which was as it should be, as this was a celebration not a scientific meeting.

Under the sponsorship of Mrs. Hugh Curran of School of Forestry Campus, a talented group of young radio broadcasters from Manila gave an excellent concert at Center in the evening of November 25. The receipts will go to a fund to purchase a radio and earphones for use of patients in the College Infirmary. The audience was appreciative but far too small considering the object and that the artists gave their services.

A letter to Professor Velmonte, Head of Department of Economics from Mr. Pablo Mabbun, University Fellow, University of Wisconsin tells of his passing the preliminary examinations for doctorate degree with agricultural economics as major.

The eighty-eighth regular scientific meeting of the Los Baños Biological Club was held in the Lecture Hall of the Poultry Building, College of Agriculture, on Thursday, December 14, 1933, at 7:30 p. m.

The following papers were read and discussed:

1. "Effects of pre-heating on the operation of a high compression tractor engine using alcohol and alcohol-gasoline blends as fuels"

   By Dr. A. L. Teodoro

2. "Studies on the morphology of the Meliaceae: II. Sterility in santol (*Sandoricum koetjape*) (Burm. f.) Merr."

   By Dr. J. B. Juliano

The Secretary of the College reports the following students as having received marks of distinction at the close of the first semester of the academic year, 1933-34, based on the final ratings in October:

RANK	NAME	AVERAGE RATING [a]	ACADEMIC LOAD [b]	CLASS
1st.	Demeterio, Jose K.	1.55	22	1st. Year, B.S.S.T.
2nd.	Dalisay, Amando M.	1.66	15	1st. Year, B.S.A.
3rd.	Ancheta, Teofilo R.	1.70	22	1st. Year, B.S.S.T.
3rd.	Batenga, Dominador E.	1.70	22	3rd. Year, B.S.S.T.
4th.	Pangga, Cecilio A.	1 80	15	1st. Year, B.S.A.
5th.	Macaspac, Isidro S.	1 83	22	1st. Year, B.S.A.
6th.	Perez, Zoilo M.	1.87	22	1st. Year, B.S.S.T.
7th.	Catapang, Lauro R.	1 89	22	1st. Year, B.S.A.
8th.	Makabali, Gregorio B.	2 00	19 [c]	4th. Year, B S.S.T.

[a] The average rating was computed by multiplying the final rating obtained by the student in each course by the number of units carried by such course and dividing the sum of the products by the total number of units carried by the student.

[b] Only students carrying regular loads (minimum of 15 units for working students and 20 units for regular students) were considered.

[c] Excluding credits on thesis.

THE MOST PROFITABLE INVESTMENT OF THE GOVERNMENT OF THE UNITED STATES

Scientific research conducted by the Federal Government is its most profitable investment. Among the millions and the billions for wars, past, present and future, for post offices, for Congress, for prohibition enforcement, for Indians, for interest on the public debt, for RFC and other dollar transfusions to the financial structure, for relief, for reforestation, there are items of a few thousands and hundreds of thousands of dollars for scientific research.

The United States Department of Agriculture scientists are finding new uses for familiar farm products, fighting soil erosion, improving live stock, protecting plants and crops, and safeguarding the ordinary consumer against bad food and drugs. In far off China or the tropics, explorers of the department roam to bring back strange plants that help our farmers. Within our country's borders, entomologists are combating the insect menace.

United States Geological Survey geologists are mapping and surveying the mineral domain that the machine age [illegible]ot die of starvation. Government Coast and Survey ships and [illegible]neers are surveying our coasts to safeguard commerce and shipping.

Out in that group of Washington laboratories, not near the oratory of Congress, there are men and women of the United States Bureau of Standards staff studying the rainbow of chemical elements, developing new facts about heat, stressing steel and newer metals, perfecting standards, methods and processes of incalculable value to industry and pursuing a thousand other useful scientific tasks.

Astronomers at the United States Naval Observatory observe the stars in order that our watches and clocks may have the correct time. Meteorologists of the United States Weather Bureau observe and forecast the weather for farmers, aviators and city folks. United States Bureau of Mines engineers by experiments, practical and theoretical, safeguard and develop the mines of the nation.

The appropriations for such scientific research functions of the federal government are the best investments made by the government. The returns to the public in terms of percentage run to figures like 50,000 per cent instead of the conventional 6 per cent that bankers have popularized.

PHILIPPINE AGRICULTURIST, VOL. XXII, NO. 10, MARCH, 1934

True, the profits do not flow back into the United States Treasury directly as dollars. The profits are made not by Uncle Sam but by the American public. That is fitting, for the business of the government is not to make money, but to undertake functions that benefit the whole people.

Scientific research is often a long-time investment, with the benefits going to our children and their children. It is a safe investment. Unlike bonds of maturity in the year 2000 or later, issued to pay for rails that even now are rusting away, the money spent for fundamental scientific research is a secure investment that will continue to pay public service dividends down through the ages.

If you think of the budget of the United States Government as a gigantic pie, the slice that is eaten to provide scientific research and service, which is perhaps the most profitable of its many activities, is so small that it can barely be seen. Of the federal dollar, less than seven-eighths of a cent is expended for the constructive scientific research and service conducted to the profit of the whole nation.

This 85 hundredths of one per cent (based on the 1931-32 expenditures) includes all the administrative, clerical and other routine expenses in connection with the government's scientific work. If the salaries of the scientists themselves and the money expended for apparatus, etc., were considered alone, the item would be much smaller, so minute that it would be difficult to find it among the millions upon millions of dollars that pass through Uncle Sam's pocketbook. Obviously the federal budget can never be balanced by eliminating any or all of the scientific work of the Federal Government.

The crippling of an essential scientific investigation or service here and another there may give a feeling of righteousness and go through the motions of cutting down government expenditures, but it will not balance the budget or materially lift the tax burden. The effect will be hardship on the farmer, the manufacturer or the consumer in later years when the much greater direct tax of undone scientific research will be felt.

Not only will the ultimate consumer and future generations lose, but Uncle Sam himself will find his day-to-day routine governmental activities made more expensive if the scientists are fired. In addition to fundamental and applied scientific research, the federal scientific bureaus perform tests that assure that the government gets its money's worth in purchasing supplies, erecting buildings, etc.

If a total is obtained of all the money spent by the government for all kinds of research, education and developmental work, not just scientific research and service, it is found that only 2.7 per cent of the United States expenditures is accounted for. Who then eats Uncle Sam's budget pie?

Wars, past and future, gobble 75.2 per cent of the federal budget. Warships, soldiers, veterans, interest and retirement of debts from past wars, and their incidentals consumed $3,758,000,000 of the United States 1931-32 expenditures. Compare this cost of warfare and national defense with $42,000,000 for scientific work, both research and service, in 1931-32. Of the 1934 budget presented to Congress last fall, less than $35,000,000 is devoted to scientific research and service.

The legislative, executive and judicial functions of the Federal Government consumed 12.6 per cent of the 1932 expenditures, and public works in 1931-32 were responsible for 9.5 per cent of the expenditures.

Meeting the annual **bill for profitable scientific research** in the United States budget is a **relatively small matter from a financial** standpoint. The complete elimination **of the annual federal** investment in scientific research, which is unthinkable, would not help materially in "balancing the budget." The annual *per capita* cost is only about 30 cents. The *per capita* cost of all federal government activities runs from $30 to $40 per year, depending upon what year is taken.—WATSON DAVIS.

Science—Supplement, April 14, 1933.

Arthur Brisbane on being asked for a signed **article for** The Cornell Daily Sun, the campus newspaper wrote: "**I shall be glad** to give you, instead of an article, nine words from **Shakespeare worth** more to young men and women than all the **articles that I or a** dozen others ever wrote. Ninety per cent of the **young men at Cornell** will read these lines some day, and years **hence perhaps will** wish they had read them and thought about **them earlier. These** are the nine words: **'I wasted time, and now doth time waste me.'**"

From *The* [illegible] *Council Bulletin*

The farmer's slogan: "Breed, Feed and Weed."

Queensland Agricultural Journal September, 1933

The purities

Table 1 gives the results of the Walker method and those obtained when the clarified solution was inverted with 1:1 phosphoric acid kept in the bath for periods of 25 minutes and of 40 minutes maintained at 65°C. The gravity purity of the solution in Walker's method was found to be 38.67 $\mp$ 0.03326; that of the one kept in the bath for a period of 25 minutes, 38.31 $\mp$ 0.0292. It may be seen that inversion is not complete, assuming that complete inversion has taken place in the use of Walker's method. The difference was found to be significant. By keeping the solution in the bath for 40 minutes and then allowing the flask to stand in the room for 30 minutes before diluting to the volume, the gravity purity was found to be 38.91 $\mp$ 0.4445. It may be seen that the gravity purity was higher than that obtained with the Walker method. The difference was found to be significant.

Table 2 shows the results of the analysis of a molasses sample with the use of the Walker method and with that of the proposed method. Inversion with the use of hydrochloric acid gave a gravity purity of 39.11 $\mp$ 0.0924. Inverting the solution with phosphoric acid and keeping the flask in the bath for a period of 30 minutes and cooling immediately to room temperature gave a gravity purity of [illegible]57 [illegible]. It may be readily seen that inversion is not yet complete. [illegible] the solution was kept in the bath for 30 minutes and then allowed to stand for 30 minutes in the room before diluting and cooling, the gravity purity was found to be 38.99 $\mp$ 0.0228. There was a slight increase in the gravity purity caused by standing before diluting and cooling. Keeping the solution in the bath for 40 minutes and then cooling immediately to room temperature, the gravity purity was found to be 39.27 $\mp$ 0.03022. Likewise, with solutions kept for 40 minutes and allowed to stand for the usual 30-minute period, the gravity purity was 39.31 $\mp$ 0.02934. It is readily seen then that inversion could be completed by keeping the solutions in the bath for 40 minutes at 65°C. Allowing the solutions to stand for 30 minutes in the room with occasional shaking did not materially increase the gravity purity. The probable error of the difference was found to be insignificant.

Table 3 shows the results of the analysis of molasses by the three methods; namely, the invertase method; Walker's method; and the proposed method. The excess of the lead salts used for clarification was removed by the use of dry monobasic potassium phosphate. The gravity purity of the solution using the invertase method of hydrolysis was 36.99 $\mp$ 0.03709. Using Walker's method, the purity

was 36.81 $\mp$ 0.04607. If determined with the use of phosphoric acid, the gravity purity was 35.75 $\mp$ 0.03885; if digested for 35 minutes in the bath and cooled immediately, 36.87 $\mp$ 0.03433; if digested for 35 minutes and allowed to stand further for another 30 minutes at room temperature without increasing the rate of cooling, 36.82 $\mp$ 0.06893; if digested for 40 minutes, cooled right away and diluted to the volume, 36.96 $\mp$ 0.0169; if digested for 40 minutes and allowed to stand for another 30 minutes. From the results it may be readily seen that inversion could be completed by digesting the solution at a temperature of 65°C. for 35 minutes and cooling the solution at once. Inversion could, however, be completed by allowing the solution to stand for 30 minutes before final dilution is made; and by digesting the solution for 40 minutes in the bath and cooling immediately. The probable error of the difference of the gravity purities at periods of 30 minutes and of 40 minutes was insignificant.

Table 4 gives a repetition of the process used in table 3. It may be seen in this table that inversion can be completed in 40 minutes time but not quite in 35 minutes.

Assuming that complete inversion takes place when the flasks are kept at 65°C. in the bath for 40 minutes and 30 minutes standing in the room, this procedure was tried on two samples of sugars; seven samples of molasses; and a sample of syrup (see table 5). It may be readily seen that a closer approximation of the amount of sucrose in the sample could be attained with the use of the proposed method than with the well known Walker method, using the invertase hydrolysis as the standard.

SUMMARY

1. The possibility of using a 1:1 phosphoric acid as inverting agent in the double polarization method for estimating sucrose has been shown, thus eliminating the so-called acid influence.

2. The color of the solution inverted with hydrochloric acid was found to be deeper than that of the solution inverted with phosphoric acid.

3. The direct reading could be obtained even with the use of 1:1 phosphoric acid, provided it was taken immediately after completing to the required volume.

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TABLE 1

Showing the gravity purities of the samples by the use of Walker's method and by the proposed method

CORRECTED BRIX	DIRECT READING	POL'N	GRAV. PUR.	WALKER'S METHOD				PROPOSED METHOD							
								25 min. in bath and 30 min. standing				40 min. in bath and 30 min. standing			
				Invert reading	Temp.	Sucrose	Grav pur.	Invert reading	Temp.	Sucrose	Grav. pur.	Invert reading	Temp.	Sucrose	Grav. pur.
15.27	14.20	3.51	32.63	—7.42	27.6	41.29	38.50	7.30	27.6	41.06	38.29	7.58	27.8	41.58	38.87
	14.13	3.49	32.53	—7.60	27.6	41.51	38.70	7.30	27.6	40.97	38.20	7.50	27.6	41.31	38.62
	14.20	3.51	32.69	—7.60	27.6	41.63	38.82	7.25	27.6	41.02	38.24	7.55	28.0	41.58	38.87
	14.26	3.52	32.83	—7.40	27.6	41.36	38.57	7.32	27.6	41.21	38.43	7.60	27.6	41.66	38.94
	14.20	3.51	32.69	—7.51	27.6	41.46	38.66	7.26	27.6	40.99	38.22	7.70	28.0	41.88	39.15
	14.30	3.53	32.92	—7.50	27.6	41.63	38.82	7.3	27.6	41.26	38.47	7.50	28.0	41.71	38.90
	—	—	—	—7.51	—	41.48	38.67	7.29	—	41.23	38.31	7.66	—	41.62	38.91
P. Em.	—	—	—	—	—	—	±0.03326	—	—	—	±0.02920	—	—	—	±0.04445

TABLE 2

Showing the gravity purities of sample of molasses by the Walker's and the proposed method

CORRECTED BRIX	DIRECT READING	POL'N	GRAV. PUR.	WALKER'S METHOD				PROPOSED METHOD: 30 min. in bath and cooled at once			
				Invert reading	Temp.	Sucrose	Grav. pur.	Invert reading	Temp.	Sucrose	Grav. pur.
15.62	14.66	36.16	33.02	—7.66	28.4	42.69	38.99	—7.13	28.4	41.68	38.06
	14.60	36.01	32.89	—7.60	28.4	42.15	38.49	—7.03	28.8	41.43	37.84
	14.70	36.25	33.11	—7.96	28.4	43.36	39.60	—7.50	28.6	42.49	38.81
	14.80	36.50	33.34	—7.62	28.6	42.91	39.19	—7.34	28.6	42.89	39.17
	14.71	36.28	33.13	—7.71	28.4	42.89	39.17	—7.44	28.6	42.42	38.74
	14.7	36.25	33.11	—7.76	28.4	42.96	39.24	—7.50	28.6	42.49	38.81
				—7.72		42.82	39.11	—7.32	—	42.23	38.57
P. Em.							±0.0924				±0.1295

PROPOSED METHOD: 30 min. in bath and 30 min. standing				40 min. in bath and cooled at once				40 min. in bath and 30 min. standing			
Invert reading	Temp.	Sucrose	Grav. pur.	Invert reading	Temp.	Sucrose	Grav. pur.	Invert reading	Temp.	Sucrose	Grav. pur.
—7.68	28.6	42.42	38.74	—7.85	28.4	43.06	39.33	—7.90	28.4	43.16	39.42
—7.50	28.6	42.37	38.69	—7.95	28.4	43.14	39.39	—7.90	28.4	43.04	39.30
—7.53	28.6	42.74	39.03	—7.68	28.6	42.84	39.12	—7.83	28.4	43.18	39.44
—7.63	28.6	43.09	39.35	—7.66	28.4	43.04	39.30	—7.68	28.6	43.04	39.30
—7.71	28.6	42.77	39.05	—7.66	28.6	42.84	39.12	—7.68	28.4	42.77	39.12
—7.62	28.6	42.82	39.10	—7.80	28.6	43.09	39.35	—7.78	28.4	43.01	39.28
—7.61	—	42.86	38.99	—7.76	—	43.00	39.27	—7.81	—	43.03	39.31
P. Em.			±0.1228				±0.03022				±0.02934

TABLE 3

Showing the gravity purities of sample of molasses by the Walker invertase and the proposed method

CORRECTED BRIX	DIRECT READING	POL'N	GRAV. PUR.	WALKER'S METHOD				INVERTASE METHOD				PROPOSED METHOD 35 min. in bath and cooled at once	
				Invert reading	Temp.	Sucrose	Grav. pur.	Invert reading	Temp.	Sucrose	Grav. pur.	Invert reading	Temp.
15.32	14.60	35.91	31.34	—7.90	27.2	42.72	36.97	—7.92	27.4	42.79	39.04	—7.26	27.4
	14.40	35.41	30.91	—7.80	27.2	42.18	36.50	—7.90	27.4	42.42	36.72	—7.28	27.4
	14.53	35.73	31.19	—7.86	27.2	42.52	36.80	—8.02	26.8	42.74	36.99	—7.18	27.4
	14.50	35.66	31.13	—7.82	27.2	42.40	36.70	—8.00	27.0	42.69	36.95	—7.18	27.4
	14.66	36.05	31.47	—7.81	27.2	42.64	36.91	—7.95	26.8	42.87	37.10	—7.12	27.6
	14.60	35.91	31.34	—7.88	27.2	42.69	36.95	—8.00	27.0	42.89	37.12	—7.14	27.6
	—	—	—	—7.85	—	42.52	36.81	—7.99	—	42.73	36.99	—7.19	—
P. Em.							±0.04607				±0.03709		

PROPOSED METHOD 35 min. in bath and cooled at once		35 min. in bath and allow to stand				40 min. in bath and cooled at once				40 min. in bath and allow to stand			
Sucrose	Grav. pur.	Invert reading	Temp.	Sucrose	Grav. pur.	Invert reading	Temp.	Sucrose	Grav. pur.	Invert reading	Temp.	Sucrose	Grav. pur.
41.54	35.95	—7.92	26.8	42.69	36.95	—7.86	27.2	42.64	36.91	—7.90	27.4	42.77	37.01
41.12	35.59	—7.96	26.8	42.40	36.7	—7.70	27.8	42.08	26.12	—8.04	26.8	42.57	36.84
41.24	35.69	—8.00	27.0	42.74	36.82	—7.98	27.2	42.74	36.99	—7.98	26.8	42.67	36.93
41.19	35.64	—7.92	26.8	42.5	36.78	—7.74	27.2	42.23	36.55	—8.00	26.8	42.64	36.91
41.41	35.81	—7.92	26.8	42.72	36.97	—7.92	27.2	42.87	37.10	—7.95	26.6	42.87	37.10
41.31	35.76	—7.95	26.8	42.74	36.99	—7.86	27.4	42.69	36.95	—7.94	26.6	42.72	36.97
41.30	35.75	—7.95	—	42.63	36.87	—7.84	—	42.55	36.82	—7.97	—	42.71	36.96
	±0.03885				±0.03433				±0.06893				±0.0169

TABLE 4

Showing the gravity purities of sample of molasses by the Walker invertase and proposed method

CORRECTED BRIX	DIRECT READING	POL'N	GRAV. PUR.	WALKER'S METHOD Invert reading	WALKER'S METHOD Temp.	WALKER'S METHOD Sucrose	WALKER'S METHOD Grav. pur.	INVERTASE METHOD Invert reading	INVERTASE METHOD Temp.	INVERTASE METHOD Sucrose	INVERTASE METHOD Grav. pur.	PROPOSED METHOD 35 min. in bath and cooled at once Invert reading	PROPOSED METHOD 35 min. in bath and cooled at once Temp.
15.4	14.44	3.55	30.73	—7.62	27.0	41.85	36.23	—8.03	27.0	42.60	36.89	—7.43	27.0
	14.32	3.52	30.48	—7.40	27.0	41.21	36.67	—8.06	27.0	42.31	36.63	—7.50	27.0
	14.24	3.52	30.52	—7.74	27.0	41.87	36.25	—8.00	27.0	42.38	36.70	—7.23	27.0
	14.40	3.54	30.65	—7.54	27.0	41.62	36.03	—8.06	27.0	42.60	36.89	—7.23	27.0
	14.30	3.52	30.43	—7.66	27.0	14.65	36.06	—8.03	27.0	42.33	36.65	—7.30	27.0
	14.40	3.54	30.65	—8.02	27.0	42.53	36.82	—8.13	27.0	42.73	36.99	—7.30	27.0
	14.30	3.52	30.43	—7.85	27.0	42.0	36.38	—7.96	27.0	42.21	36.55	—7.26	27.4
	14.40	3.54	30.65	—7.78	27.0	42.06	36.42	—7.96	27.0	42.41	36.72	—7.36	27.2
	14.33	3.52	30.50	—7.74	27.0	41.87	36.25	—7.96	27.0	42.28	36.61	—7.30	27.2
	14.40	3.54	30.65	—7.78	27.0	42.06	36.42	—8.03	27.0	42.53	31.82	—7.36	27.0
	—	—	—	—7.72	—	41.87	36.25	—8.02	—	42.45	36.75	—7.33	—
P. Em.							±0.06003				±0.03076		

PROPOSED METHOD: 35 min. in bath and cooled at once Sucrose	35 min. in bath and cooled at once Grav. pur.	35 min. in bath and stood for 30 min. Invert reading	35 min. in bath and stood for 30 min. Temp.	35 min. in bath and stood for 30 min. Sucrose	35 min. in bath and stood for 30 min. Grav. pur.	40 min. in bath and cold Invert reading	40 min. in bath and cold Temp.	40 min. in bath and cold Sucrose	40 min. in bath and cold Grav. pur.	40 min. in bath and stood for 30 min. Invert reading	40 min. in bath and stood for 30 min. Temp.	40 min. in bath and stood for 30 min. Sucrose	40 min. in bath and stood for 30 min. Grav. pur.
41.47	35.90	—7.50	27.2	41.65	36.06	—7.93	26.8	42.38	36.70	—7.96	27.0	42.48	36.7
41.37	35.82	—7.50	27.0	41.40	35.84	—7.96	26.8	42.24	36.57	—8.03	27.0	42.41	36.70
40.91	35.42	—7.60	27.0	41.62	36.04	—8.00	27.0	42.38	36.70	—7.90	27.0	42.19	36.83
41.03	35.53	—7.70	27.0	41.92	36.29	—8.00	27.0	42.51	36.80	—8.13	26.8	42.70	36.92
40.98	35.48	—7.90	27.0	42.11	36.46	—7.93	27.0	42.16	36.50	—8.06	26.8	42.38	36.78
40.98	35.48	—7.76	27.0	42.04	36.40	—7.93	27.0	42.38	36.70	—8.13	26.8	42.70	36.75
40.96	35.46	—7.96	27.0	42.21	36.55	—7.96	27.2	42.26	36.59	—7.92	27.0	42.16	36.50
41.28	35.74	—7.73	27.0	41.96	36.33	—7.80	27.4	42.19	36.53	—7.86	27.0	42.24	36.57
41.06	35.55	—7.76	27.0	41.89	36.27	—7.83	27.4	42.11	36.46	—7.93	27.0	42.24	36.57
41.28	35.74	—7.76	27.0	42.04	36.40	—7.90	27.4	42.36	36.67	—7.90	27.0	42.31	36.63
41.13	35.61	—7.72	—	41.96	36.26	—7.92	—	42.30	36.62	—7.98	—	42.38	36.66
	±0.03649				±0.04681				±0.02314				±0.02664

TABLE 5

Showing the analysis of sugars, final molasses and syrup by the Walker invertase and the proposed method

	CORRECTED BRIX	DIRECT READING	POL'N	GRAV. PUR.	WALKER'S METHOD				INVERTASE METHOD				PROPOSED METHOD: 40 min. in bath and 30 min. standing			
					Invert reading	Temp.	Sucrose	Grav. pur.	Invert reading	Temp.	Sucrose	Grav. pur.	Invert reading	Temp.	Sucrose	Grav. pur.
Sugars ..		96.42	96.42		—14.58	25.2	96.16		—14.6	25.6	96.33		—14.68	25.2	96.31	
		96.00	96.00		—14.68	25.2	95.98		—14.7	25.6	96.17		—14.78	25.2	96.14	
Molasses	15.42	12.94	31.80	27.55	—8.18	26.4	53.33	31.63	—8.26	26.0	53.35	34.64	—8.20	26.0	53.23	34.57
	14.36	11.92	29.42	27.42	—6.80	26.0	47.39	32.91	—6.66	26.8	47.39	32.91	—6.66	26.8	47.39	32.91
	11.90	12.12	31.21	33.85	—7.12	26.2	49.24	41.37	—7.24	26.4	50.26	42.21	—7.22	26.4	49.54	41.63
	15.00	12.02	29.60	26.17	—9.12	26.4	53.48	35.66	—9.12	26.4	53.53	35.69	—9.12	26.4	53.53	35.69
	14.69	13.66	33.69	30.55	—8.17	26.2	54.71	36.21	—8.16	26.7	55.30	37.62	—8.17	26.4	55.19	37.55
	15.14	11.17	27.50	24.28	—9.37	24.6	52.01	34.41	—9.65	24.6	52.72	34.92	—9.48	26.8	52.30	34.64
	13.64	12.01	29.74	29.15	—7.70	27.2	50.29	34.31	—7.87	24.8	50.84	34.68	—7.88	27.2	50.76	34.63
Syrup ...	12.9	33.62	8.35	86.19	—10.44	25.6	11.17	87.06	—10.6	25.6	11.27	87.37	-10.58	25.8	11.27	87.39

REPORT ON TRUCK FIELD TESTS IN CANLUBANG, LAGUNA, USING A-ALKOHL MOTOR FUEL No. 1, B-DEHYDRATED ALCOHOL AND GASOLINE AS FUELS

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WITH TWO CHARTS

INTRODUCTION

Alcohol has been used as a fuel for motor transportation and for tractors in Calamba Sugar Estate, Canlubang, Laguna, since 1922. At present, there is no internal combustion engine on the Estate that does not operate on alcohol. During the milling season, the Estate's trucks, numbering over thirty, are daily used for hauling canes from the fields to the loading stations. It is the purpose of this report to present some field data which may show the approximate amount of fuel consumed by trucks used for hauling canes in the Estate.

Objects of the present study

The objects of the present study may be grouped as follows:

1. To determine the average economy of such fuels as A-alkohl motor fuel No. 1, B-dehydrated alcohol, and gasoline under different conditions.

2. To measure engine wear and degree of carbon deposit in the combustion chamber.

3. To study the behavior of the engines when different fuels are used.

Time and place of work

The field test was conducted mostly in Biñang and also in Mañgumit, Canlubang, Laguna between February 20 and March 16, 1933.

The fields in Biñang, where three trucks hauled cane, are fairly level, except one, called G. I. lot, which is hilly. The grade ranged from 10 to 25 per cent. The hilly route was about 100 meters. The trucks hauled cane on the G. I. lot during the last four days only; the rest of the work for three weeks was done on level ground. The

[1] College of Agriculture Experiment Station contribution No. 945. Read before the Los Baños Biological Club June 22, 1933. Received for publication January 10, 1934.

routes consisted of temporary roads, called table roads, and of rough plowed fields. The shortest hauling distance in Biñang was about 0.18 kilometer and the longest 2.83 kilometers.

Three other trucks hauled canes in the Mañgumit district. The land in Mañgumit is rolling with a grade ranging from 10 to 15 per cent. The routes here were also table roads and over rough plowed fields. The shortest hauling distance was 0.1 kilometer and the longest, 1.43 kilometers. Short hauling distances of from 0.1 kilometer to 0.3 kilometer were more frequent in Mañgumit than in Biñang.

Personnel

The investigation was headed by A. L. Teodoro assisted by J. P. Mamisao, Macario Abad, Antonio Oliver, Jose M. Dakis, Estanislao Veras, Emiliano Fermin, Francisco Peña, Norberto Eulogio, Maximino Galisanao, Lucio Morales, Rufino Beato. The determination of engine wear, carbon deposit, and change in viscosities was performed by E. D. Hemedes and E. Quirit. The whole project was carried out at the request of Vice President L. Weinzheimer and Resident Manager O. G. C. Milne of the Calamba Sugar Estate.

MATERIALS AND METHODS

Trucks. Six Chevrolet trucks were used. Table 1 shows an approximate description of these trucks.

Fuels. The fuels used were A-alkohl motor fuel No. 1,[2] B-dehydrated alcohol,[3] and gasoline.

The constituents by volume of A-alkohl motor fuel No. 1 are:

	Per cent
Alcohol (about 95 per cent by volume)	99.00
Gasoline	0.50
Aniline	0.50
	100.00

Lubricating oil. Mobiloil A.

Equipment: Viscosimeter. Saybolt Standard Universal Viscosimeter manufactured by C. J. Tagliabue Mfg. Co., New York.

Analytical balance. Manufactured by Henry Troemner, Philadelphia, Pennsylvania.

[2] Data supplied by the Chief Chemist of A-motor alcohol manufacturer.

[3] Approximately 98.5 per cent alcohol by volume. Prepared by B-motor alcohol manufacturer.

Procedure of tests

Overhauling the engine. Before beginning the field tests all the engines were overhauled in the Shop Department under the direction of M. Abad and A. Oliver. Carbon deposits in the cylinder heads, valve heads, valve seats, pistons, rings, and spark plugs were removed. All the rings were weighed before fitting them to the pistons.

Adjustment of the engine. Prior to the tests, great care was taken by A. Oliver and his assistants to adjust the carburetors of the different engines. Two entirely new carburetors were fitted to the trucks that used gasoline. For A-alkohl motor fuel No. 1, jet No. 54 and for B-dehydrated alcohol, jet No. 55 were used for trucks with regular up-draft carburetors and jets Nos. 40 and 42 for trucks with down-draft carburetors.[4] With gasoline, jet No. 56 was used for up-draft carburetor and jet No. 45 for down-draft carburetor. The jet areas, using gasoline as unity, were approximately 1.3 for B-dehydrated alcohol and 1.4 for A-alkohl motor fuel No. 1. Each carburetor was considered well adjusted when a condition of operation was reached in which the engine just ceased to backfire at full throttle on no load with wide open choke.

Series of tests. Two series of tests, A and B, were made for each fuel. In series A, three trucks with regular up-draft carburetors were used. Three trucks with down-draft carburetors were used in series B (see table 1).

Determination of required data

All hauling distances were measured in kilometers as recorded in the truck's speedometer. A day's test was composed of many trips back and forth from starting point in the cane field to loading station. Proper corrections for distances were made when trucks were run on reverse from the road to any point in the field where the canes were gathered.

Fuel consumption. The amount of fuel consumed in each test was given in liters measured at field temperature. Before any test was started, the fuel tank was filled to the neck. The amount of fuel added to reach the same mark of the tank at the end of the test represented the fuel consumption for that test. In filling the tank, care was taken to eliminate air pockets which might make the result inaccurate.

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[4] The number of jet given represents the size of twist drill used for boring the jet.

The fuel economy was computed in miles per gallon. A set of data was taken in hauling the canes from cane field to loading station and returning without load from loading station to cane field. The mileage per gallon obtained in this set was termed load-mile per gallon. Another set of data was gathered by the same process except that the truck was not loaded from the cane field to the loading station. The mileage per gallon in this set was termed no-load-mile per gallon. This was done in all tests in order to determine the extra amount of fuel necessary to haul the canes.

Stops. Intentional stops were those made by stopping the engine from three to eight minutes when the canes were being loaded into the truck. Unintentional stops were those made because of fault in the engine. Idling were stops made without killing the engine.

Carbon deposits. The amount of carbon deposits was measured by weight. Blunt instruments were used to remove the carbon. In cleaning, care was taken not to scrape the metal part.

Ring wear. Each ring was weighed on an analytical balance before and after the test. The loss in weight represented the wear expressed in grams.

Corrosive effects. Corrosive effects were determined by ocular inspection.

RESULTS AND DISCUSSION

Fuel consumption

Table 2 gives a fair indication that the greater the hauling distance the larger the mileage per given volume of the fuel. The three trucks using up-draft carburetors showed very low mileage per gallon. The hauling averages varied from about 2.5 miles per gallon at about 0.1 mile hauling distance to approximately 4.5 miles per gallon at 0.6 mile hauling distance. For no-load tests over the same route, about 1.5 miles per gallon was the increase over the loaded rate (see table 3). As shown in chart 1, gasoline indicated the best result for average mileage per gallon, A-alkohl motor fuel No. 1 was a very close second, and B-dehydrated alcohol was third. With gasoline fuel as 100 per cent, the average for A-alkohl motor fuel No. 1 was between 98-99 per cent and for B-dehydrated alcohol 90 per cent (see table 4). With no-load test, gasoline was first, B-dehydrated, second, and A-alkohl motor fuel No. 1, third. B-dehydrated alcohol averaged about 93 per cent and A-alkohl motor fuel No. 1, 91 per cent. Note that the smooth curves, as shown in chart 1, are considered the

most probable lines which represent, in general, the mean values of the figures given in tables 2 and 3.

The results obtained with trucks using down-draft carburetors also showed in general that the greater the hauling distance the greater the mileage per gallon. There was a big difference in the

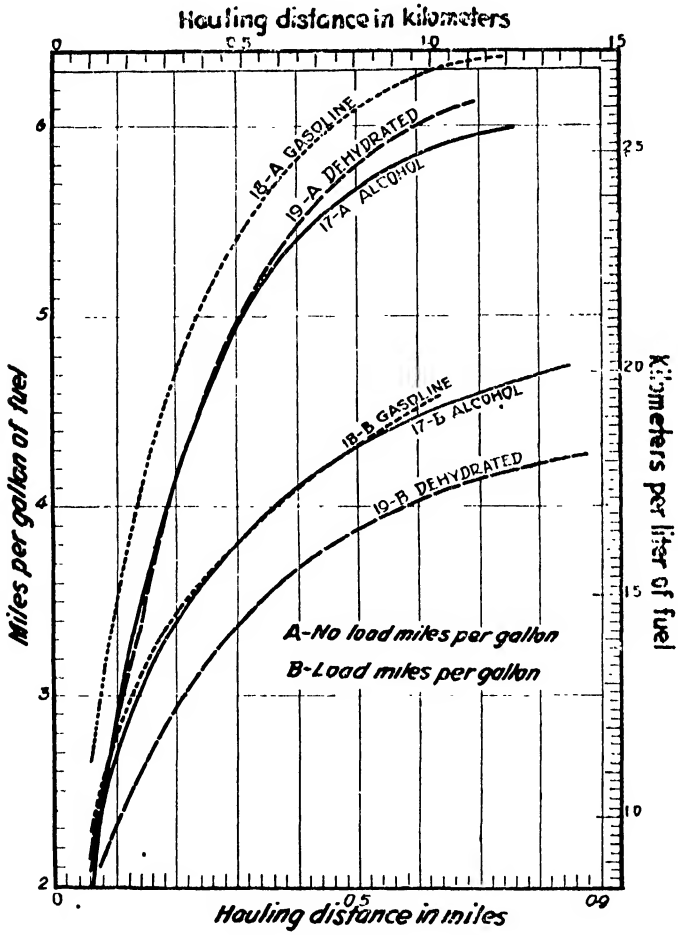

Chart 1.—Showing results of test using trucks with up-draft carburetors.

nature of the two hauling areas; one was nearly level and the distance was short, the other was undulating and rugged and the distance was relatively long.

Tables 5 and 6, show the mileage per gallon that was obtained for load and for no-load tests. Gasoline was easily the first, A-alkhol motor fuel No. 1 was second, and B-dehydrated alcohol was third.

With gasoline as 100 per cent, B-dehydrated alcohol averaged from 47 per cent to 60 per cent and A-alkohl motor fuel No. 1, 50 per cent to 76 per cent (see table 7). The differences were extraordinarily large as compared with the results obtained using up-draft carburetors (see chart 2).

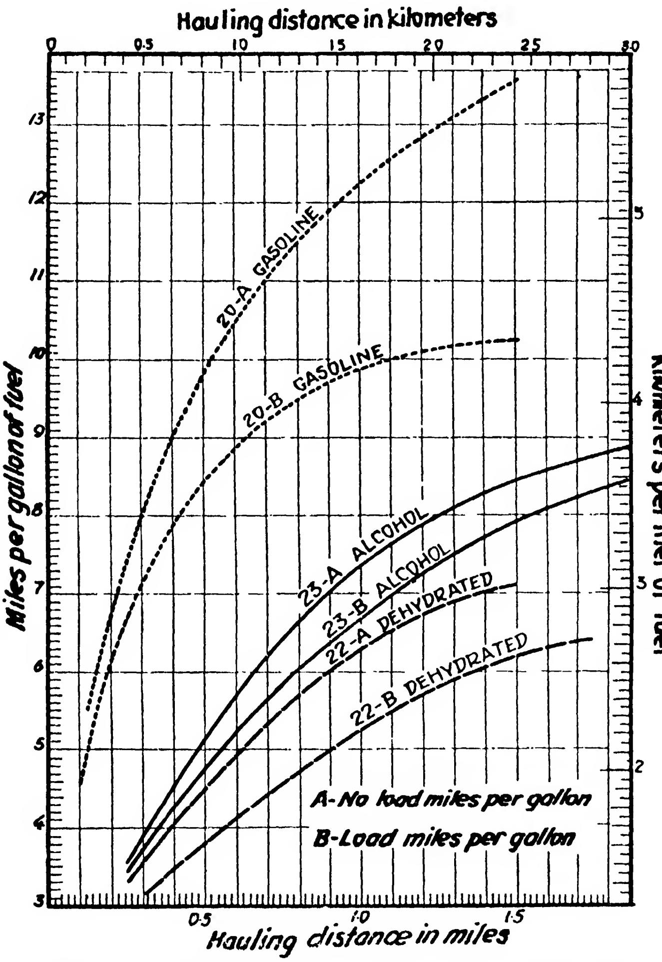

Chart 2.—Showing results of tests using trucks with down-draft carburetors.

Table 8 clearly indicates that the no-load miles per gallon exceeded by over 30 per cent that of the load miles per gallon in the trucks with up-draft carburetors and with trucks having down-draft carburetors by about 20 per cent. The test with gasoline showed that the greater the hauling distance, the larger the difference. A-alkohl

motor fuel No. 1 showed a difference of scarcely 10 per cent when down-draft carburetor was used. Note that with the use of up-draft carburetor and B-dehydrated alcohol, the average mileage for no-load test was almost double that with load test.

The number of intentional stops given in tables 9, 10, and 11, will show the actual number of trips made from the cane fields to the hauling stations and from the hauling stations back to the fields. It can easily be seen that if the stops per mile and the number of runs on first, second, and reverse gear were considered the average miles per gallon could not be of very high value under the Canlubang conditions.

It is indicated in table 12, that the average cooling water temperature for trucks using up-draft carburetor is highest on B-dehydrated alcohol and lowest on gasoline. With down-draft carburetor, B-dehydrated alcohol has still the highest temperature and A-alkohl motor fuel No. 1, the lowest. The temperature of the crankcase oil, using up-draft carburetor, is highest on B-dehydrated alcohol and lowest on gasoline. With down-draft carburetors, alcohol is highest and gasoline, lowest.

CARBON DEPOSIT

The following conclusions are shown by the results of tests on carbon deposit (table 13):

1. The largest amount of carbon deposit appeared on the cylinder head.

2. The amount of carbon deposit (reduced to 1000 kilometers of speedometer travel) was least with A-alkohl motor fuel No. 1 as fuel and largest with B-dehydrated alcohol. With gasoline as 100 per cent, the percentages are 91.3 per cent for A-alkohl motor fuel No. 1 and 133.6 per cent for B-dehydrated alcohol using up-draft carburetors; and 81.4 per cent for A-alkohl motor fuel No. 1 and 202.6 per cent for B-dehydrated alcohol using down-draft carburetors.

The carbon deposits using A-alkohl motor fuel No. 1 and B-dehydrated alcohol were somewhat moist and tarry. Some valve stems showed signs of being gummy.

It was very evident that with down-draft carburetors, the spark plugs were quite clean.

There was no indication of any of the valves being corroded or burned.

RING WEAR

The results on ring wear point to the following conclusions (table 14):

1. The wear in compression ring No. 2 was not as much as that in compression ring No. 1 or in the oil ring.

2. Using up-draft carburetor the degree of wear (reduced to 1000 kilometers of speedometer travel) was least on A-alkohl motor fuel No. 1 and greatest on B-dehydrated alcohol. Considering the wear using gasoline as 100 per cent, with A-alkohl motor fuel No. 1 it was only 64.7 per cent and with B-dehydrated alcohol, 142.2 per cent.

3. With down-draft carburetor, the relative values were 100 per cent with gasoline, 121.3 per cent with B-dehydrated alcohol and 247.5 per cent with A-alkohl motor fuel No. 1.

CONSUMPTION, DILUTION AND VISCOSITY OF OIL

Very inaccurate records were obtained with regard to consumption, dilution, and change in viscosity of the crankcase oil. The results were not considered and no discussion is given.

BEHAVIOR OF ENGINES UNDER OPERATION

Starting. Starting from cold was just as easy using A-alkohl motor fuel No. 1 as using B-dehydrated alcohol or gasoline. It is to be noted, however, that the warming up period was shortest with gasoline and longest with A-alkohl motor fuel No. 1. Using alcohol, drivers who were not very careful made unnecessary unintentional stops because the engines were not warmed up when the gears were shifted. Too much choking when starting oftentimes made the engine using gasoline fail to start. With A-alkohl motor fuel No. 1, this defect was not very evident.

Flexibility. The engines were undoubtedly more responsive to sudden changes of load and speed with the use of gasoline than with any of the alcohol fuels. B-dehydrated alcohol was a little better than A-alkohl motor fuel No. 1 in this point. Under the conditions in which the engines were tested, there was no evident difference in the tendency to show sign of laboring when maximum power was developed.

Corrosion. No evidence of corrosion was observed in any of the six engines tested. When the engines were overhauled after the test, not one showed any sign of having been abused, nor were the pistons and valves burned or scorched.

SUMMARY AND CONCLUSIONS

The results of the field tests confirmed the following beliefs which are fairly widely accepted:

1. That all other things being equal the shorter the hauling distance the shorter is the average mileage per given volume of fuel.

2. Considerable amount of fuel is used unnecessarily by frequent starting and stopping of engine and by habitual running on first gear, second gear and reverse.

3. The fuel consumption on level ground and on good roads is less than on plowed field and on rolling areas.

The results indicated the following:

1. The use of different engines of the same make and nearly of the same age under nearly the same Canlubang conditions pointed to the conclusion that with the carburetors adjusted to give satisfactory operation on different fuels, the consumption of gasoline was least, A-alkohl motor fuel No. 1 next and B-dehydrated alcohol the greatest. Note that these results were based upon the weighted averages of more than 1000 tests. Considering the consumption with gasoline as 100 per cent, A-alkohl motor fuel No. 1 had 102 to 103 per cent and B-dehydrated alcohol 110 per cent when up-draft carburetors were used. With down-draft carburetors, the percentage for A-alkohl motor fuel No. 1 was from 150 to 178 per cent and for B-dehydrated alcohol from 145 to 160 per cent.

2. The use of different fuels for the same engine (see table 16) indicated that all other things being equal, gasoline was first in miles per gallon and A-alkohl motor fuel No. 1 last. With the mileage per unit volume of A-alkohol motor fuel No. 1 as basic unit, the equivalent averaged amounts for dehydrated alcohol and for gasoline were, respectively, 1.078 and 1.909 with up-draft carburetor and 1.320 and 1.932 with down-draft carburetors. The averages were nearly 1.2 for dehydrated and 1.9 for gasoline.

3. Considering the average ring wear per 1000 kilometers of trav and using A-alkohl motor fuel No. 1 as basic unit, the ratios for gasoThe ca for B-dehydrated alcohol were respectively 1.54 and 2.19 witted alcoh carburetor and 0.40 and 0.49 with down-draft carburetorwed signs eptional high piston ring wear, as shown by the truck us It was veryith up-draft carburetor, might be due to the fact that thugs were quite ewer by about 500 kilometers than the others tested.

There was no deposit reduced to grams per 1000 kilometers was urned. tor fuel No. 1 and largest in B-dehydrated alcohol.

5. The cooling water temperature was never beyond the normal requirement during any of the tests. B-dehydrated alcohol indicated higher averages than either A-alkohl motor fuel No. 1 or gasoline.

6. Fair operation of the engines was maintained during all the tests. Gasoline fuel was a little better than any of the alcohol fuels in points of flexibility and load pick up. There was hardly any difference between them in ease of starting. A-alkohl motor fuel No. 1 needed longer time for warming up the engine than either gasoline or B-dehydrated alcohol. No objectionable odors were produced with alcohol fuels when the engines were operated under adverse conditions.

TABLE 1

Description of the different engines used

TRUCK NO.	MODEL	CYLINDER SIZE	RATED POWER	APPROXIMATE AGE	SPEEDOMETER DISTANCE COVERED: Before test	SPEEDOMETER DISTANCE COVERED: After test	SPEEDOMETER DISTANCE COVERED: Distance covered	FUEL USED	WEIGHT OF TRUCK: Truck alone	WEIGHT OF TRUCK: Truck with driver and checker
		inches	*h. p.*	*months*	*km.*	*km.*	*km.*		*kgm.*	*kgm.*
				With up-draft carburetor						
17	Independence	3-5/16" × 3-3/4"	(N.A.C.C.)—26.3	17	11,800.0	13,346.0	1546.0	A-alkohl motor fuel No. 1	1915	2020
18				17	11,220.5	12,171.0	950.5	Gasoline	1900	2010
19				17	8,594.0	9,588.0	994.0	B-dehydrated alcohol	1890	1995
				With down-draft carburetor						
20	Confederate	6 cylinders	Horsepower	5	4,554.0	6,643.0	2089.0	Gasoline	1935	2040
22				5	5,330.0	7,315.0	1985.0	B-dehydrated alcohol	1922	2037
23				5	4,075.0	6,735.0	2660.0	A-alkohl motor fuel No. 1	1910	2010

Approximate load of each truck 1.1 to 1.2 metric tons.

TABLE 2

Average load miles per gallon[a]

17 A-ALKOHL MOTOR FUEL NO. 1		18 GASOLINE		19 B-DEHYDRATED ALCOHOL	
Hauling distance	Fuel economy	Hauling distance	Fuel economy	Hauling distance	Fuel economy
km.	*mi./gal.*	*km.*	*mi./gal.*	*km.*	*mi./gal.*
0.100	1.66	0.1042	1.861	0.236	2.14
.2005	2.385	.265	1.92	.225	2.445
.1038	2.505	.2045	2.845	.242	2.47
.1688	2.54	.1437	2.871	.175	2.59
.1906	2.628	.1875	2.911	.1906	2.682
.7335	2.85	.236	3.01	.2625	2.754
.1936	2.905	.3870	3.095	.25	2.757
.2275	3.015	.2189	3.138	.2745	2.799
.265	3.02	.2521	3.162	.398	3.091
.430	3.091	.300	3.378	.1875	3.00
.1452	3.195	.4415	3.705	.4400	3.27
.2417	3.21	.552	3.74	.508	3.40
.2581	3.27	.1593	3.81	.700	3.47
.266	3.63	.524	3.936	.580	3.52
.536	3.64	.814	4.11	.265	3.561
.449	3.715	.241	4.135	.259	3.712
.414	3.72	.937	4.265	.702	3.815
.2375	3.84	.7125	4.41	1.028	3.98
1.125	4.05	.225	4.59	1.154	3.984
.938	4.18	——	——	.275	4.195
1.3	5.37	——	——	1.425	4.285

[a] Weighted average. With up-draft carburetors.

TABLE 3

Average no-load miles per gallon [a]

17 A-ALKOHL MOTOR FUEL NO. 1		18 GASOLINE		19 B-DEHYDRATED ALCOHOL	
Hauling distance	Fuel economy	Hauling distance	Fuel economy	Hauling distance	Fuel economy
km.	*mi./gal.*	*km.*	*mi./gal.*	*km.*	*mi./gal.*
0.2005	2.90	1.43	2.55	1.425	2.255
0.2417	2.95	0.265	2.568	0.1906	3.012
0.1936	3.145	0.300	2.927	0.225	3.170
0.1688	3.16	0.2045	3.625	0.175	3.295
0.2275	3.305	0.2189	3.72	0.25	3.353
0.1906	3.37	0.2521	3.74	0.508	3.60
0.265	3.71	0.1437	3.815	0.265	3.85
0.414	4.232	0.3870	4.32	0.2625	3.99
0.2581	4.255	0.1042	4.382	0.236	4.00
0.100	4.49	0.236	4.585	0.440	4.07
0.536	4.55	0.1875	4.731	0.398	4.26
0.449	4.752	0.241	5.09	0.275	4.37
0.266	4.845	0.937	5.34	0.259	4.41
0.430	4.85	1.197	5.515	0.2745	4.735
0.2375	4.87	0.524	5.55	0.580	5.22
0.1038	5.21	0.814	5.69	0.242	5.37
0.7335	5.355	0.552	6.31	0.700	5.52
1.125	5.455	0.225	6.49	1.154	5.53
1.3	5.695	0.7125	6.54	0.702	6.43
0.938	6.25	0.4415	7.8	1.028	7.81

[a] Weighted average. With up-draft carburetors.

TABLE 4

Mileage per gallon as derived from curves based on weighted averages

HAULING DISTANCE IN KILOMETER	LOAD MILES PER GALLON			NO-LOAD MILES PER GALLON		
	18 Gasoline	19 B-dehydrated alcohol	17 A-alkohl motor fuel No. 1	18 Gasoline	19 B-dehydrated alcohol	17 A-alkohl motor fuel No. 1
0.1	2.36 1.00	1.91 0.81	2.04 0.86	2.66 1.00	2.10 0.79	2.20 0.82
0.2	2.94 1.00	2.49 0.85	2.85 0.97	3.85 1.00	3.12 0.81	3.23 0.84
0.3	3.30 1.00	2.89 0.87	3.34 1.01	4.58 1.00	3.96 0.86	4.03 0.88
0.4	3.59 1.00	3.19 0.89	3.65 1.02	5.07 1.00	4.58 0.90	4.60 0.91
0.5	3.81 1.00	3.42 0.90	3.88 1.02	5.45 1.00	5.03 0.92	5.00 0.92
0.6	4.00 1.00	3.61 0.90	4.05 1.01	5.72 1.00	5.35 0.93	5.29 0.92
0.7	4.16 1.00	3.76 0.90	4.19 1.01	5.93 1.00	5.61 0.94	5.50 0.93
0.8	4.31 1.00	3.89 0.90	4.31 1.00	6.08 1.00	5.80 0.95	5.67 0.93
0.9	4.44 1.00	3.99 0.90	4.41 0.99	6.20 1.00	5.94 0.96	5.79 0.93
1.0	4.57 1.00	4.07 0.89	4.50 0.98	6.29 1.00	6.05 0.96	5.88 0.93

TABLE 5

Average load miles per gallon[a]

20 GASOLINE		22 B-DEHYDRATED ALCOHOL		23 A-ALKOHL MOTOR FUEL NO. 1	
Hauling distance	Fuel economy	Hauling distance	Fuel economy	Hauling distance	Fuel economy
km.	*mi./gal.*	*km.*	*mi./gal.*	*km.*	*mi./gal.*
0.625	4.655	0.328	2.121	0.18	2.382
.3225	4.935	.145	2.278	.328	2.582
.260	5.23	.215	2.52	.155	2.655
.221	5.41	.18	2.655	.34	3.465
.145	5.65	.65	3.08	1.31	3.642
.308	6.185	.59	3.905	.70	3.655
.2182	6.69	1.56	3.905	.3125	3.739
1.07	7.22	.84	3.95	.155	4.12
.972	7.785	1.026	4.025	1.2	4.545
1.05	7.93	1.009	4.14	.57	4.705
.904	8.04	1.08	4.185	1.034	4.733
.575	8.325	1.0025	4.196	.905	4.856
1.07	8.74	1.1875	4.295	1.58	5.04
.971	8.93	1.167	4.785	1.0093	5.12
1.081	9.29	1.63	4.83	0.657	5.26
1.267	9.58	2.55	5.015	.996	5.54
2.7	9.88	.918	6.29	.758	5.673
2.825	9.94	2.20	7.08	2.50	5.79
1.381	10.12	——	——	2.05	7.615
2.14	10.20	——	——	2.50	8.16
1.2475	11.95	——	——	1.148	9.24

[a]Weighted average. With down-draft carburetors.

TABLE 6

Average no-load miles per gallon [a]

20 GASOLINE		22 B-DEHYDRATED ALCOHOL		23 A-ALKOHL MOTOR FUEL NO. 1	
Hauling distance	Fuel economy	Hauling distance	Fuel economy	Hauling distance	Fuel economy
km.	*mi./gal.*	*km.*	*mi./gal.*	*km.*	*mi./gal.*
0.308	2.463	0.328	2.568	0.3125	2.638
0.3225	5.68	0.18	3.745	0.328	2.712
0.145	6.115	0.145	3.85	0.70	3.00
0.971	6.97	0.65	4.005	0.758	4.55
0.575	7.595	1.167	4.20	1.31	4.61
0.972	7.86	2.55	4.31	0.996	4.664
0.221	8.165	1.0025	4.322	0.155	4.935
2.70	9.53	1.08	4.43	1.034	5.085
2.825	9.80	2.20	4.43	2.50	5.27
2.14	10.24	0.59	4.51	0.155	5.40
1.07	10.46	0.918	4.725	2.05	6.025
1.050	10.75	1.1875	4.73	1.0093	6.23
0.904	11.00	0.84	4.815	0.657	6.52
1.381	11.10	0.215	5.185	1.200	6.70
1.081	12.21	1.56	5.742	0.905	6.86
1.2475	12.81	1.009	6.21	1.58	7.00
1.07	13.51	1.026	6.69	2.50	7.02
1.267	13.87	——	——	0.57	7.20
——	——	——	——	0.18	7.94
——	——	——	——	1.148	8.40

[a] Weighted average. With down-draft carburetors.

TABLE 7

Mileage per gallon as derived from curves based on weighted averages

HAULING DISTANCE IN KILOMETER	LOAD MILES PER GALLON			NO-LOAD MILES PER GALLON		
	20 Gasoline	22 B-dehydrated alcohol	23 A-alkohl motor fuel No. 1	20 Gasoline	22 B-dehydrated alcohol	23 A-alkohl motor fuel No. 1
0.2	5.12	2.42	2.50	5.50	2.56	—
	1.00	0.47	0.49	1.00	0.47	—
0.3	6.02	2.68	2.98	6.61	2.94	—
	1.00	0.45	0.50	1.00	0.44	—
0.4	6.76	2.92	3.43	7.50	3.30	3.52
	1.00	0.43	0.51	1.00	0.44	0.47
0.5	7.30	3.17	3.82	8.20	3.64	4.00
	1.00	0.43	0.52	1.00	0.44	0.49
0.6	7.74	3.38	4.18	8.80	3.94	4.40
	1.00	0.44	0.54	1.00	0.45	0.50
0.7	8.12	3.59	4.50	9.35	4.22	4.80
	1.00	0.44	0.55	1.00	0.45	0.51
0.8	8.45	3.80	4.80	9.81	4.51	5.17
	1.00	0.45	0.57	1.00	0.46	0.53
0.9	8.73	4.00	5.10	10.26	4.79	5.51
	1.00	0.46	0.58	1.00	0.47	0.54
1.0	8.97	4.20	5.36	10.64	5.04	5.87
	1.00	0.47	0.60	1.00	0.47	0.55
1.1	9.18	4.40	5.62	10.97	5.28	6.17
	1.00	0.48	0.61	1.00	0.48	0.56
1.2	9.37	4.58	5.85	11.27	5.52	6.45
	1.00	0.49	0.62	1.00	0.49	0.57
1.3	9.54	4.77	6.08	11.55	5.74	6.71
	1.00	0.50	0.64	1.00	0.49	0.58
1.4	9.66	4.93	6.29	11.80	5.93	6.95
	1.00	0.51	0.65	1.00	0.50	0.59
1.5	9.78	5.10	6.48	12.01	6.10	7.16
	1.00	0.52	0.66	1.00	0.51	0.60
1.6	9.87	5.26	6.68	12.21	6.27	7.35
	1.00	0.53	0.68	1.00	0.51	0.60
1.7	9.95	5.41	6.85	12.41	6.42	7.53
	1.00	0.54	0.69	1.00	0.52	0.61
1.8	10.01	5.56	7.03	12.61	6.56	7.70
	1.00	0.56	0.70	1.00	0.52	0.61
1.9	10.07	5.69	7.20	12.80	6.69	7.85
	1.00	0.57	0.72	1.00	0.52	0.61
2.0	10.12	5.81	7.36	12.98	6.80	8.00
	1.00	0.57	0.73	1.00	0.52	0.62
2.1	10.16	5.92	7.50	13.14	6.90	8.12
	1.00	0.58	0.74	1.00	0.52	0.62
2.2	10.19	6.02	7.64	13.28	6.99	8.22
	1.00	0.59	0.75	1.00	0.53	0.62
2.3	10.21	6.11	7.78	13.40	7.06	8.33
	1.00	0.60	0.76	1.00	0.53	0.62

TABLE 8

Ratio of no-load miles per gallon to load miles per gallon

HAULING DISTANCE IN KILOMETER	GASOLINE		B-DEHYDRATED ALCOHOL		A-ALKOHL MOTOR FUEL NO. 1	
	18	20	19	22	17	23
0.1	1.13	—	1.10	—	1.08	—
0.2	1.31	1.07	1.25	1.06	1.13	—
0.3	1.39	1.10	1.37	1.10	1.21	—
0.4	1.41	1.11	1.44	1.13	1.26	1.03
0.5	1.43	1.12	1.47	1.15	1.29	1.05
0.6	1.43	1.14	1.48	1.17	1.30	1.05
0.7	1.43	1.15	1.49	1.18	1.31	1.07
0.8	1.41	1.16	1.49	1.19	1.31	1.08
0.9	1.40	1.18	1.49	1.19	1.31	1.08
1.0	1.38	1.19	1.49	1.20	1.31	1.09
1.1	—	1.19	1.48	1.20	1.29	1.10
1.2	—	1.20	—	1.20	1.28	1.10
1.3	—	1.21	—	1.20	—	1.10
1.4	—	1.22	—	1.20	—	1.10
1.5	—	1.23	—	1.20	—	1.10
1.6	—	1.24	—	1.19	—	1.10
1.7	—	1.25	—	1.19	—	1.10
1.8	—	1.26	—	1.18	—	1.09
1.9	—	1.27	—	1.18	—	1.09
2.0	—	1.28	—	1.17	—	1.09
2.1	—	1.29	—	1.17	—	1.08
2.2	—	1.30	—	1.16	—	1.07
2.3	—	1.31	—	1.16	—	1.07
2.4	—	1.32	—	1.15	—	1.06
2.5	—	1.33	—	—	—	1.06

TABLE 9

Total number of stops made during the tests

18 (GASOLINE)				20 (GASOLINE)			
Hauling distance in kilometer	Intentional stops	Unintentional stops	Total	Hauling distance in kilometer	Intentional stops	Unintentional stops	Total
0.1042	19	—	19	0.625	13	2	15
0.2650	—	—	—	0.3225	—	—	—
0.2045	26	5	31	0.26	18	—	18
0.1437	15	8	23	0.221	46	—	46
0.1875	24	10	34	0.145	21	—	21
0.236	25	—	25	0.308	13	2	15
0.3870	48	5	53	0.2182	33	1	34
0.2189	25	4	29	1.07	22	—	22
0.2521	29	11	40	0.972	49	—	49
0.300	24	—	24	1.050	44	—	44
0.4415	16	1	17	0.904	44	—	44
0.552	37	3	40	0.575	40	1	41
0.1593	17	2	19	1.07	14	—	14
0.524	29	4	33	0.971	38	—	38
0.814	16	1	17	1.081	38	2	40
0.241	24	7	31	1.267	37	—	37
0.937	19	—	19	2.70	29	—	29
0.7125	7	—	7	2.825	20	—	20
0.225	4	—	4	1.381	53	—	53
0.197	24	—	24	2.14	35	—	35
0.143	18	—	18	1.2475	36	—	36

TABLE 10

Total number of stops made during the tests

19 B-DEHYDRATED ALCOHOL				22 B-DEHYDRATED ALCOHOL			
Hauling distance in kilometer	Intentional stops	Unintentional stops	Total	Hauling distance in kilometer	Intentional stops	Unintentional stops	Total
0.236	26	4	30	0.328	—	—	—
0.225	23	4	27	0.145	17	—	17
0.242	20	—	20	0.215	19	—	19
0.175	14	—	14	0.18	35	—	35
0.1906	23	1	24	0.65	10	1	11
0.2625	24	—	24	0.59	7	—	7
0.25	25	—	25	1.56	33	—	33
0.2745	32	3	35	0.84	21	1	22
0.398	45	1	46	1.026	36	1	37
0.1875	17	2	19	1.009	56	—	56
0.440	17	2	19	1.08	45	2	47
0.508	37	—	37	1.0025	49	1	50
0.700	7	—	7	1.1875	46	—	46
0.580	22	6	28	1.167	42	1	43
0.265	—	—	—	1.63	44	—	44
0.259	23	2	25	2.55	32	—	32
0.702	17	2	19	0.918	44	—	44
1.028	19	—	19	2.20	42	—	42
1.154	24	—	24	—	—	—	—
0.275	4	—	4	—	—	—	—
1.425	22	3	25	—	—	—	—

TABLE 11

Total number of stops made during the tests

17 A-ALKOHIL MOTOR FUEL NO. 1				23 A-ALKOHIL MOTOR FUEL NO. 1			
Hauling distance in kilometer	Intentional stops	Unintentional stops	Total	Hauling distance in kilometer	Intentional stops	Unintentional stops	Total
0.1000	21	1	22	0.18	18	—	18
0.2005	—	—	—	0.328	—	—	—
0.1038	15	1	16	0.155	28	—	28
0.1688	16	1	17	0.34	34	—	34
0.1906	24	2	26	1.31	43	—	43
0.7335	7	1	8	0.70	10	1	11
0.1936	26	1	27	0.3125	15	—	15
0.2275	22	—	22	0.155	47	—	47
0.2650	—	—	—	1.2	44	1	45
0.430	17	1	18	0.57	7	—	7
0.1452	17	3	20	1.034	41	6	47
0.2417	24	—	24	0.905	32	1	33
0.2581	28	1	29	1.58	34	—	34
0.266	23	1	24	1.0093	41	2	43
0.536	26	3	29	0.657	50	—	50
0.449	30	3	33	0.996	42	1	43
0.414	51	1	52	0.758	46	—	46
0.2375	4	—	4	2.50	31	—	31
1.125	17	—	17	2.05	33	—	33
0.938	20	—	20	2.50	26	—	26
1.300	18	2	20	1.148	49	—	49

TABLE 12

Temperature of crank case oil and of cooling water [a]

DATE	LOAD TEST						NO-LOAD TEST					
	Water temperature			Oil temperature			Water temperature			Oil temperature		
	A-alkohl motor fuel No. 1	B-dehydrated alcohol	Gasoline	A-alkohl motor fuel No. 1	B-dehydrated alcohol	Gasoline	A-alkohl motor fuel No. 1	B-dehydrated alcohol	Gasoline	A-alkohl motor fuel No. 1	B-dehydrated alcohol	Gasoline
	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.
2-20-33							151	153	140	118	120	102
							170	155	171	138	125	
2-21-33			155			125	166	160	148	141	137	127
	159	160	146	145	142	119	163	164	161	145	124	142
2-22-33	148	149	145	119	107	108	160	179	150	144	130	128
	163	163	142	140	140	124	176	176	181	144	144	146
2-23-33	160	157	139	120	135	199	156	178	147	131	141	130
	152	141	148	124	141	112	166	168	174	136	128	124
2-24-33												
	159	148	156	146	132	130	170	168	174	146	136	142
2-25-33	162	178	142	132	124	116	170	184	252	158	142	151
	164	172	166	138	144	142	154	168	172	131	154	152
2-27-33							175	182	163	144	146	135
	160	168	172	138	136	164	176	152	173	144	136	160
2-28-33	164	176	160	126	130	125	143	164	139	129	135	124
	158	174	164	150	160	154	161		154	146		141
3- 1-33	170	188	160	128	140	126	171	192	161	132	138	124
	159	161	163	142	156	132	155	171	160	118	154	141
3- 2-33	159	178	149	126	136	124	166	175	154	140	138	130
	159	165		156	150	148	170	162	164	152	144	144
3- 3-33						150	152	176	138	124	136	116
3- 5-33	160	140	151	120	122	112	145	164	136	122	124	116
	149	178	148	130	133	118	151	168	171	128	132	136
3- 6-33	136	152	140	120	125	114	146	166	138	116	122	110
	166	164	171	150	138	134	153	159	166	134	140	148
3- 7-33	158	177	154	136	138	126	146	167	142	130	131	128
	151	156	158	138	128	132	154	154	160	130	131	132
3- 8-33	165	178	150	138	141	122	169	185	161	144	154	138
	156	161	159	134	128	136	158	164	148	136	139	132
3- 9-33	163	171	150	140	144	131	160	183	154	146	152	144
	164	167	158	148	142	132	164	154	140	139	134	133
3-10-33	151	161	143	122	130	118	158	181	152	148	158	142
	158	167	163	148	136	142	160	152	159	144	136	134
3-11-33	114	170	144	126	134	122						
	166	168	160	152	140	142	158	158	156	148	150	138
3-13-33	130	134	104									
		164	142		142	138	148	152	147	145	132	136
3-14-33												
	140	149	152	136	131	144	140	148	113	138	129	142
3-15-33												
	159	156	161	136	151	150	151		160	138		142
3-16-33	162	174	174	141	138	144	152	166	170	147	144	142
	169		174	136		138	161		174	132		138

[a] Upper figures are for trucks 17, 18, and 19.
Lower figures are for trucks 20, 22, and 23.

TABLE 13

Carbon deposits

TRUCK NO.	FUEL USED	TYPE OF CARBURETOR	PISTON HEAD	CYLINDER		VALVES	SPARK PLUGS [a]	TOTAL	AVERAGE TOTAL CARBON DEPOSIT
				Head	Walls				
			grams	*grams*	*grams*	*grams*	*grams*	*grams*	*gr./1000 km.*
17	A-alkohl motor fuel No. 1	Up draft	5.7236	14.6610	1.9370	1.9960	0.1184	24.4360	15.8124
18	Gasoline	" "	5.6460	14.4064	1.4990	0.6630	0.1090	16.4590	17.3161
19	B-dehydrated alcohol	" "	5.7430	8.4450	2.4780	0.3330	0.1420	23.0054	23.1438
20	Gasoline	Down draft	5.9930	7.1860	0.9170	0.3730	0.0240	14.4930	6.9378
22	B-dehydrated alcohol	" "	7.9780	15.1630	3.4900	1.1890	0.0930	27.9130	14.0620
23	A-alkohl motor fuel No. 1	" "	4.9440	7.8060	2.1960	Trace	0.0740	15.0200	5.6466

[a] For three spark plugs only.

TABLE 14

Ring wear

TRUCK NO.	FUEL USED	TYPE OF CARBURETOR	RING WEAR				TOTAL DISTANCES COVERED	AVERAGE RING WEAR
			Compression 1	Compression 2	Oil	Total		
			grams	*grams*	*grams*	*grams*	*grams*	*gr./1000 km.*
17	A-alkohl motor fuel No. 1	Up draft	2.3496	1.5050	2.3178	6.1724	1546.0	3.9925
18	Gasoline	" "	2.1880	1.8312	1.8420	5.8612	950.5	6.1664
19	B-dehydrated alcohol	" "	2.9212	2.4816	3.3175	8.7203	994.0	8.7729
20	Gasoline	Down draft ..	1.1464	0.7802	1.0344	2.9610	2089.0	1.4174
22	B-dehydrated alcohol	" "	1.1030	0.6876	1.6242	3.4148	1985.0	1.7203
23	A-alkohl motor fuel No. 1	" "	3.4868	2.2546	3.5903	9.3317	2660.0	3.5081

[a] For three spark plugs only.

TABLE 15

Equivalent amount of fuel used in terms of gasoline (based on special tests[a])

TRUCK NO.	GASOLINE		B-DEHYDRATED ALCOHOL		A-ALKOHL MOTOR FUEL NO. 1	
	Amount of fuel in cc.	Relative amount	Amount of fuel in cc.	Relative amount	Amount of fuel in cc.	Relative amount
			With up-draft carburetor			
17	3000	1.000	4620	1.540	4720	1.573
18	2200 [b]	1.000	6030	2.740	6000	2.723
19	3900	1.000	4600	1.180	5670	1.452
Average	3033	1.000	5083	1.675	5463	1.804
			With down-draft carburetor			
20	4950	1.000	5370	1.085	7800	1.575
22	4090	1.000	6000	1.467	9000	2.190
23	4200	1.000	8400	2.003	8400	2.000
Average	4413	1.000	6600	1.495	8400	1.903

[a] Special tests along a course of nearly 24 km. with 1.2 tons load.
[b] Doubtful data.

TABLE 16

Special straight run load test[a]
Average load, 1.2 tons

TRUCK NO.	A-ALKOHL MOTOR FUEL NO. 1		B-DEHYDRATED ALCOHOL		GASOLINE	
	Up-draft carburetor					
	No. 54 jet [b]		No. 55 jet		No. 56-57 jet	
	km./l.	*mi./gal.*	*km./l.*	*mi./gal.*	*km./l.*	*mi./gal.*
17	4.96	11.66	5.09	11.96	7.73	18.18
18	3.92	9.22	3.86	9.08	10.68	25.12 [c]
19	4.20	9.88	5.15	12.11	6.10	14.36
	Down-draft carburetor					
	No. 40 jet		No. 42-1/4 jet		No. 45 jet	
20	3.05	7.12	4.41	10.38	4.79	11.26
22	2.63	6.19	3.98	9.37	5.84	13.75
23	2.86	6.72	2.87	6.76	5.74	13.50

[a] Route: From garage to coconut plantation via Majada—to Mañgumit—to Bontog, back to Mañgumit—then to garage. Total distance—23 km. No stop. No idling. Average speed—15 to 35 km./hr. Time—50 to 60 minutes.
[b] Standard Tool Co. gauge measurement.
[c] Data doubtful.

TABLE 17

Equivalent amount of mileage covered per unit volume in terms of A-alkohl motor fuel No. 1 (based on special straight run load test. Table 16)

TRUCK NO.	A-ALKOHL MOTOR FUEL NO. 1	B-DEHYDRATED ALCOHOL	GASOLINE
	Up-draft carburetor		
17	1.000	1.025	1.558
18	1.000	0.984	2.720 [a]
19	1.000	1.225	1.451
	Down-draft carburetor		
20	1.000	1.445	1.570
22	1.000	1.512	2.220
23	1.000	1.004	2.005
Average	1.000	1.199	1.921
Up-draft	1.000	1.078	1.909
Down-draft	1.000	1.320	1.932
Cost factor [b]	·0.520	0.624	1.000

[a] Data doubtful.

[b] Factor by which the cost of gasoline may be multiplied to get the equivalent cost of other fuel to make them equally as economical. (Based on weighted average using six trucks.)

LIVING CONDITIONS IN FARM HOMES IN MENDEZ NUÑEZ AND AMADEO, CAVITE; MANGATAREM, PANGASINAN; AND CAMILING, TARLAC.[1]

JOSÉ E. VELMONTE, JUAN O. SUMAGUI AND PEDRO H. VIRAY[2]

In an agricultural country like the Philippine Islands, it is of value to know whether or not the farmer receives adequate returns for his labor. The question resolves itself primarily into a discussion and analysis of income, but this alone would fall short of a full appraisal of adequate returns. It would be of value to inquire further how this income is spent, and the satisfactions derived from the spending. The question further leads to a comparison of the satisfaction which the farmer derives from his farming and that obtained by those following other occupations. These discussions inevitably lead to a measurement of the farmer's standard of living. There is, however, no unanimity of opinion as regards the term standard of living. It is by some defined as the sum of satisfactions customarily enjoyed by a person or family. By others, it is described as the amount of necessities, comforts and luxuries which an individual or family is accustomed to enjoy and insists upon having. As satisfactions are subjective, the standard of living is incapable of exact measurement. It is, however, commonly understood to include only those conditions of life measurable as economic goods and it is in this sense in which it is used in this paper. Even with this limitation, to measure the farmer's standard of living is not an easy matter because there is a great diversity of standards of living among individuals and families as the standard depends to a very great extent on income and incomes are variable.

In so far as the standard of living involves an analysis of the cost of living of farmers, the principal aspects of the present work are a determination of the value of all goods used by the family; the part of the family living which is furnished by the farm; and the distri-

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bution of the total value among the principal groups of goods. Such an analysis gives a definite idea of farm family living. It is not, however, without shortcomings. As a large portion of the goods used in farm homes is furnished directly by the farm, their money costs are not easily determined. Furthermore, money values are not absolute measures of the degree of satisfaction derived from food, clothing and other goods. It is further complicated by the fact that the purchasing power of money changes. Finally, any comparison of the level of living of farmers with that of those following other occupations, as city workers for example, is not easily made, for urban conditions and satisfactions are far different from rural.

REVIEW OF LITERATURE

Rosenberg (1903)[3], a commissioner of the American Federation of Labor, who visited Manila estimated the minimum cost of supporting a family of five persons in the city of Manila at $105 a year.

Clark (1905) in his study of labor conditions in the Philippine Islands made observations on the cost of articles of necessity as follows: The food ration of a Filipino laborer consisted of a chupa of rice, some fish and vegetables. The cost of a full ration was estimated to be the equivalent of twelve and one-half cents, U. S. currency. Rice in Manila cost $2.52 per cavan, fresh beef about $0.20 a pound, Chinese eggs at about $0.125 per dozen, water for household purposes, less than one-half cent per can of 5 gallons.

The Philippine Bureau of Labor since 1910 has made observations on the cost of living of laborers both in the provinces and in the city of Manila. In 1910 the average daily expenses of a laboring man's family of five members was ₱1.24 distributed as follows: ₱0.66 was spent for food; ₱0.15, for clothing; ₱0.15, for rent; ₱0.08, for fuel and light; ₱0.05, for education of children; and ₱0.15, for miscellaneous. In 1918, the total was ₱1.96; in 1920, ₱2.54; and in 1925, ₱2.22.

The Philippine Bureau of labor (1926) estimated the cost of living of laborers employed in trades and industries in the city of Manila as follows: For a family of five members, the average daily expenditures was ₱2.32 distributed as follows: 59 per cent was spent for food; 7 per cent, for clothing; 11 per cent, for rent; 6 per cent, for fuel and light; 5 per cent, for education of children; and 12 per cent, for miscellaneous items.

[3] *Cited in* Labor 8: 113 p. Manila, 1927.

The Philippine Bureau of Labor (1929) undertook a more comprehensive work on the standard of living of laborers employed in the cigar factories in the city of Manila, perhaps the largest single industry in point of number of workers on its payroll. In addition, the bureau made a study of the standard of living of Insular Government employees. The results of these investigations will be separately summarized in the following paragraphs.

A survey was made of 837 laborers employed in cigar factories in Manila, of whom 454 were males and 383 were females. Sixty-seven per cent had families and 33 per cent were single. Classified by income, all the laborers included in the study were distributed as follows: 67 or 8 per cent earned from ₱3 to ₱5 per week; 325 or 38.83 per cent, from ₱5 to less than ₱7; 408 or 48.75 per cent, from ₱7 to less than ₱10; 23 or 2.75 per cent, from ₱10 to less than ₱12; and 14 or 1.67 per cent, from ₱12 and over. The average weekly expenditures for all families was ₱12.84 or the equivalent of ₱667.68 a year distributed as follows:

Food	68 per cent
Clothing	4
Shelter	8
Fuel and light	8
Miscellaneous	12
	100

Analyzing the expenditures by income groups it was observed that as the income increased, the percentage expenditures for food decreased; for clothing, remained the same; for shelter, increased; for fuel and light, approximately the same; and for miscellaneous, almost the same. It was found further that the average expenditures of a family in all income groups exceeded the income of the head of the family. It was, therefore, necessary that members of the family had to supplement that income. Not infrequently, other members of the family found employment in the same industry as the head of the family. Over 70 per cent of all laborers of the study were assisted by members of their families in earning a livelihood.

In a study of 283 families of Insular Government employees in Manila, the Bureau of Labor reported the following: The families were classified by income groups described below; the average size

of the family was 4.92 persons. The yearly expenditures were distributed as follows:

INCOME GROUPS	YEARLY EXPENSES PER FAMILY	PERCENTAGE EXPENDITURES FOR				
		food	clothing	rent	fuel and light	miscellaneous
Under ₱600 ...	₱711.00	54.01	6.75	16.88	9.70	12.66
₱600 - 900 ...	866.19	53.09	9.62	14.95	6.89	15.45
900 - 1,200 ...	1,129.65	50.63	8.98	17.13	6.27	16.99
1,200 - 1,500 ...	1,310.58	48.03	9.50	14.97	6.06	21.44
1,500 - 1,800 ...	1,661.25	46.83	11.13	16.25	5.92	19.87
1,800 - 2,400 ...	1,822.91	40.53	11.80	15.03	5.50	27.14
Average	1,250.26	47.48	10.09	15.77	6.37	20.28

OBJECT OF THE PRESENT WORK

The absence of any work on farm standards of living in the Philippine Islands emphasized the need for work in this field. The recent interest in rural improvement calls for knowledge of standards of life on the farms if its proponents achieve a fair measure of success. This need for knowledge of farm standards of living led the senior author during the last four years to plan a series of investigations which were executed by his advanced students. The materials gathered were reported in undergraduate theses in partial fulfillment of the requirements for the degrees of Bachelor of Agriculture and Bachelor of Science of Agriculture from this College. Among these theses, the two which are incorporated in this paper deal with standards of living of farmers of about the same economic level and both investigations were conducted during the same year.

Specifically, the principal objects were: a study of households and families, their size; the ages and literacy of members; living conditions, as the homes, furnishings and conveniences; an analysis of the cost of living to determine the value of all goods used and the distribution of this value among the principal groups of goods used; and finally, a comparison of the level of living of families by tenure groups.

TIME AND PLACE OF THE PRESENT WORK

The basic data from which the figures incorporated in this paper were drawn, were secured by investigations conducted in the municipalities of Mendez Nuñez and Amadeo, of the province of Cavite, from June, 1929, to January, 1930; and in the municipalities of Mangatarem of Pangasinan Province and Camiling of Tarlac Province, from August, 1929, to January, 1930.

Area studied. The municipalities of Mendez Nuñez and Amadeo are typical of the farming sections in that part of the province of Cavite known as the highlands. Previous to 1926 this region had for its principal crop, abacá. Very superior grades of fiber were obtained and good prices made it possible for the farmers to have fairly good incomes. During the world war when prices were abnormally high, the region had its share of boom prosperity. As a consequence, it developed a degree of easy living. The fall in prices after the war was severely felt and houses that were begun during the good days could not be finished. A worse disaster visited the abacá plantations. The ravages of disease wiped out the industry shortly after the war and by 1926 the people had begun to shift their activity from specialized abacá farming to diversified crop production.

Mendez Nuñez and Amadeo are located in the most southern part of Cavite on a plateau and very near the mountain range which separates the provinces of Cavite and Batangas. The farmers raise principally rice, corn, banana, vegetables and fruits. Tobacco and coconut are minor crops. In Mendez Nuñez the majority of the farmers raise, in addition, some cattle and horses on their farms, usually not more than five or six head to a farm. The sale of these animals is a regular part of the farmer's income. Household industries are not found in the farm homes. There is a seasonal movement of laborers to near-by provinces which occurs usually in July after rice has been planted and in November after the rice has been harvested.

Mangatarem, Pangasinan, and Camiling, Tarlac, are situated near each other along the boundary of the two provinces. They lie on a wide plain embraced in what is known as the Central plain of Luzon which is the rice belt of the Philippine Islands. The type of farming is identical in the two municipalities. The principal product is rice. The minor industries are live stock raising, fishing, and lumbering. Conditions of agriculture are regarded as fairly prosperous and the general condition of the two towns reflect it. Road connections are better than those of Mendez Nuñez and Amadeo.

MATERIALS AND METHODS

The schedules used for gathering the data were prepared by the senior author. The first set were to show tenure, size of farm, the homes, number, sex, age, education and literacy of members of households and families. The second set consisted of blanks to re-

cord the daily values of goods used by a family, as food, clothing, housing, furnishings, and equipment, operation goods, health, advancement, personal goods, and miscellaneous items.

The first set of schedules were filled in by the investigator from information obtained from the operator and his wife and usually with the help of the older children who invariably had received some education. The second set which consisted of blanks for every conceivable item of goods used under the various groups to which they were classified, were arranged so that each set could contain values of goods used daily for a period of one month. It was deemed expedient that a record of expenditures was to be attempted rather than to secure data of expenditures made during the year previous to the survey from farmers' estimates, as is usually done in similar investigations elsewhere. It was hoped by this method that more accurate data, relatively, than estimates would be possible, although the field covered necessarily had to be small. At the beginning of the work, the investigator began the recording of the daily values of goods used by the families so as to familiarize the operator and his wife and often the oldest child at home with the method. After a period of time, the members of the family were allowed to enter the daily values of the different goods used which were checked for accuracy by frequent visits of the investigator. At the end of the month, the schedule of expenditures were collected and a new set for the ensuing month furnished each household. As the work progressed and with the increasing familiarity of members of the household with the routine of entry, visits were made less frequently. Although the work would seem at first thought to be too complicated for the average family, a little reflection would show otherwise. Farm families of the type included in the survey had relatively very few needs and there were only a few major items used daily, as rice and one or two other items of food, and a few other articles of daily necessity. Consequently, the daily entries were few and could easily be remembered. Any gross oversight could quickly be discovered and checked by the investigator.

Since a large portion of the goods used in farm homes are furnished by the farms directly, their money costs had to be estimated. The evaluation of such goods was based upon the market price prevailing in the community at the time they were used. At the end of the period of survey, the monthly figures were totalled for each group of goods. The work in Mendez Nuñez and Amadeo consisted of an actual record covering the period from June 1, 1929, to January 31, 1930, or a total of eight months; that for Mangatarem and Camiling,

from August 1, 1929, to January 31, 1930, or a total of six months. In presenting the results of these records in this paper, the senior author reduced the original figures into a uniform and standard period of one calendar year. This procedure seemed to be justified for in examining the monthly totals, they were found to be fairly regular. Habits of consumption of the average family tended to be fairly uniform throughout the period. There were, to be sure, relatively larger values for some items in some months, as for example, in June when children start to school, during Christmas and immediately previous to it because of the harvests then being made. Despite these occasional variations, the monthly totals in the schedules were found to be fairly uniform. The figures of total values of goods used for one year as presented in this paper should, therefore, be taken as approximate.

Families included in the study were working on farms of small areas. This, therefore, would mean that the results here reported are intended to picture a standard of living on the farm close to the minimum. For example, the great majority of farms included in the survey for Mendez Nuñez were from 1 to 3 hectares; for Amadeo, from less than 1 up to 2 hectares; for Mangatarem and for Camiling, each from 1 to 3 hectares. The study also included three types of tenures which were found in the order of frequency in the regions surveyed as follows: peasant ownership, part ownership, and tenancy. Heads of households who cultivated farms which they owned were termed, owners; those who owned and cultivated a piece of land and in addition worked as a share tenant in another were classified as part owners; and finally those who worked as share tenants exclusively were termed, tenants. A total of 240 farm families were included in the survey, distributed equally in the four municipalities of Mendez Nuñez and Amadeo, Cavite, Mangatarem, Pangasinan and Camiling, Tarlac. By tenure groups, of the 60 farm families of Mendez Nuñez, 26 were owners, 26, part owners, and 8 tenants. Those of Amadeo were composed of 52 owners and 8 part owners. The 60 farm families of Mangatarem were composed of 25 farm owners, 31 part owners, and 4 tenants. Camiling farm families consisted of 42 farm owners, 11 part owners, and 7 tenants. Altogether, of the 240 farm families, 145 were farm owners, 76, part owners, and 19, tenants.

The study was limited to those families who had for operator, the father as head of the family and with very few exceptions, the

wife as home-maker was living. The operator, wife and children constituted the family. Other persons found living in the home and who were supported from the same income and shared the same table, usually close relatives were together with the family, considered as the household.

The family and the household as a unit of comparison

In comparing costs of living among the families studied, the family and household are used in this paper as units of comparison. To be sure this is not wholly free from error because of the variation in the size of families or of households and the age and sex compositions of its members, hence giving rise to differences in needs for food, clothing, and other economic goods. Other units for purposes of comparison have been offered to overcome these objections; as for example, the per capita unit, adult equivalent, or adult male equivalent, and cost consumption unit. Without going into specific analysis of their relative merits, these units also were found by other workers to be not wholly free from error. The adult male equivalent unit, for example, is regarded by some as truly scientific when based on food and other requirements of persons in different work and of different ages and sexes. As this is only feasible when dietary and other consuming habits of the people are known and since no work so far has been done on these problems, it becomes altogether unusable. Kirkpatrick (1926) in giving careful consideration to these units of comparison found that even the one generally believed to be superior; that is, the cost consumption unit was "not strikingly more effective than the total value of goods used per family". He therefore, accepted for purposes of general comparison the family and household as adequate bases for comparison.

Classification of goods used

There is no common agreement among investigators in classifying all goods used. For those goods that serve the more material needs, as food and clothing, there appears to be no disagreement. But for those goods that satisfy less material wants, there is no unanimity of opinion. What goods shall be classified under advancement? What are operation goods and what may be classified as personal goods? These and a great number of other questions arise in seeking the most satisfactory method of classification. The present classification is modeled and adapted from Kirkpatrick (1926), which is the method followed in standard of living investigations

conducted by the United States Department of Agriculture. The classification of goods follows:

1. Food.

2. Clothing: includes all expenses for wearing apparel (cost, includes sewing, shoe repairing, etc.)

3. Housing: 10 per cent of total value of house is used as annual cost of rent.

4. Household furnishings and equipment: includes all money spent for furniture, kitchen utensils, laundry equipment, sewing equipment, tableware, lamps, trunks, household tools and brooms.

5. Operation: includes expenses for fuel, kerosene, water, transportation in connection with the household business, matches, and laundry supplies as soap, bluing and starch.

6. Maintenance of health: includes money spent for household remedies, fees paid to physicians, dentists, oculists, nurses, hospital service and medicine.

7. Advancement: includes expenses for formal education of children, as tuition fees, books and all school supplies; newspapers, physical recreation and sports, board and lodging of children away from home attending school, expenses for feasts and religious celebrations, weddings, christenings, and other social gatherings.

8. Personal goods: includes all values of goods for personal uses as tobacco, jewelry, services of barber, and toilet articles.

9. Others: includes all other expenses which may not be classified under any of the above.

RESULTS AND DISCUSSION

Households and families

Members. Table 1 shows the size of family and household. A total of 240 farm families were studied, 60 each from Mendez Nuñez, Amadeo, Mangatarem, and Camiling. The first two municipalities are in the province of Cavite, the third is in Pangasinan, and the last is in Tarlac. Classified by tenures, the 60 farm families of Mendez Nuñez were composed of 26 farm owners, 26 part owners, and 8 tenants. Those of Amadeo were composed of 52 owners and 8 part owners. The 60 farm families of Mangatarem were made up of 25 farm owners, 31 part owners and 4 tenants. Camiling families were composed of 42 farm owners, 11 part owners, and 7 tenants. Altogether, of the 240 farm families studied, 145 were farm owners, 76, part owners, and 19, tenants. Tenancy was found to be negligible in the regions surveyed.

The 60 families of Mendez Nuñez were composed of 332 members or 5.50 persons per family; of Amadeo, 288 members or 4.80 persons per family; of Mangatarem, 306 members, or 5.10 persons per family; and of Camiling, 304 members or 5.07 persons per family. Altogether, the 240 farm families were composed of 1,230 members or an average of 5.12 persons per family. It is thus seen that the average size of families in all municipalities surveyed were very nearly the same.

The composition of these 240 farm families showed that of a total of 1,230 members, 731 were children at home, 52 were children not at home, mostly children attending school elsewhere, and the remainder were the parents as operators and home makers. A total of 128 other persons were found in all homes studied and these were invariably close relatives supported from the family income. Members of a family and other persons in the home taken together constitute a household. Altogether, the 240 farm households were composed of 1,358 members or an average of 5.65 persons per household. Considered by municipalities, the average size of a household in Mendez Nuñez was 6.28; in Amadeo, 5.47; in Mangatarem, 5.43; and in Camiling, 5.47. With the exception of households of Mendez Nuñez which averaged higher, the average size in all other municipalities were almost identical. The Census of the Philippine Islands in 1918 gave the average size of households in the Islands as 5.50 persons.

Age and sex of children. There were a total of 783 children in the 240 farm families studied of whom, 220 were in Mendez Nuñez; 178, in Amadeo; 192, in Mangatarem; and 193, in Camiling. Table 2 shows the age and sex distribution of children. As to sex it was found that of the 783 children, 400 were males and 383 were females. Considered by municipalities, of the 220 children of the farm families of Mendez Nuñez, 117 were males and 103 were females; of the 178 children of farm families of Amadeo, 93 were males and 85 were females; of the 192 children of Mangatarem families, 95 were males and 97 were females; and of the 193 children of Camiling families, 95 were males and 98 were females. The age distribution of children is shown in table 2. Fully 40 per cent of all children were below 10 years.

Literacy. As part of the social survey, the literacy of household members ten years or over was studied. The results are shown in table 3. In the 240 farm households studied which were composed of 1,358 members, 526 were found literate in a vernacular representing 58.90 per cent of the total members 10 years or over;

508 or 50.98 per cent were literate in English; and 24 or 2.59 per cent were literate in Spanish. Considered by municipalities, it was found that in Mendez Nuñez 70.24 per cent of the household members 10 years or over were literate in a vernacular; 41.87 per cent, in English; and 3.45 per cent, in Spanish. In Amadeo, 70 per cent were literate in a vernacular; 45.42 per cent, in English; and 1.70 per cent, in Spanish. In Mangatarem, 37.08 per cent were literate in a vernacular; 50.42 per cent, in English; and 1.67 per cent, in Spanish. In Camiling, 27.78 per cent were literate in a vernacular; 62.30 per cent, in English; and 2.38 per cent, in Spanish. The figures on literacy showed relatively much higher percentages in a vernacular for Mendez Nuñez and Amadeo than for Mangatarem and Camiling. In English, it was found that the percentages for Mangatarem and Camiling were higher than for Mendez Nuñez and Amadeo. Literacy in Spanish was negligible and was confined to a scattered few among the parents. English, however, as a common language was found to be highly important and the high percentages of literacy in this language in all regions surveyed is an indication of a general condition obtaining in the Islands because of the free public school system. The demand for public education has become so widespread during the last 30 years that the financial burden of the schools has become a chief public concern.

Extent of formal education. An attempt was made to determine the extent of formal education received by the children of the 240 farm families included in the survey. For this purpose, data on the children of owner, part owner and tenant families are presented separately in table 4. The table is made to show the highest education received by children at the time of survey. There was a total of 783 children of the 240 farm families of whom 555 or 70.88 per cent were of school age. Of these 555 children of school age, 509 or 91.71 per cent had attended school, thus showing a very high percentage of children having received the benefit of some education. The extent of education received by them was found to be as follows: 9.23 per cent had attended private Catholic schools where religious instruction in the catechism and reading and writing were the principal subjects taught; 47.74 per cent had been in the public primary schools, that is, they were fourth grade or below; 29.47 per cent had intermediate school attainments, that is, they were seventh grade or below; 10.22 per cent had from one to four years in the high school; less than 1 per cent were high school graduates; about 2 per cent had collegiate education; and about one-half of one per cent were college graduates.

Considered by tenures, the figures show that the percentages of children of school age who had formal education were uniformly very high and the figures were not very different, the minimum being 88.88 per cent in the case of part owner families and the maximum was 93.33 per cent for owner families. In analyzing, however, the extent of formal education received by children of farm families under different tenures, the figures were conclusive in showing that the extent of formal education received by children was lowest among tenant families and highest among owner families. Thus, among children of tenant families, about 68 per cent had received no education above the primary grades; nearly 28 per cent were in the intermediate grades; and about 4 per cent had attained higher education. The figures for children of owner families showed that at the time of survey, about 48 per cent had attained a primary education; about 32 per cent had reached the intermediate grades; and 20 per cent had attained higher education. These percentages were to be expected for although education is free, it still involves a relatively heavy financial burden and it is assumed that farm owners are economically more stable than families in other tenures.

Living conditions

The character and value of the house and the articles of comfort and the conveniences enjoyed in the home are normally fair indices of the level of living of a family. Data were gathered on these important aspects of family living of the 240 farm families of the study. The results are shown in table 5.

The home. To possess a home, no matter how modest its proportions, is a general desire entertained by even the poorest of Filipino farm families. It is a goal that is generally within the reach of all because of the abundance of the essential materials for a house and the ease and little cost with which they may be secured. Bamboo, nipa and cogon leaves are basic materials for modest dwellings and are found in most localities at low prices. Table 5 shows that 222 of the 240 farm families owned their homes and only 18 did not. The non-owners lived either in houses of near relatives or if tenants, in houses furnished by landlords; in neither case was rental charged. Regardless of tenure, therefore, ownership of the home was general.

The kind of materials used in the construction of the houses is a measure of the comfort and satisfaction that may be derived by those living in them. For the purposes of this work, houses were classified according to the construction materials as follows: strong materials when wood with galvanized iron for roofing are used; light

materials when only bamboo and nipa or cogon are used; mixed materials when a combination of the light and strong materials are used. The results showed that of the 240 homes studied, 63 were of strong materials; 101, of mixed materials; and 76, of light materials. Strong material houses were found in larger proportion among owner families and smaller among tenant families. Light material construction was found in larger proportion among tenants and less among owners.

The size of the houses of all families studied cannot be described satisfactorily for purposes of comparison. The number of rooms, however, is usually accepted as the most satisfactory measure of the size of the house. On this basis, table 5 shows that homes of owner families were largest, averaging 3.83 rooms to a household, and tenant family homes were smallest, averaging 3.23 rooms to a household. The differences, however, in the three tenure classes were too small to be significant. For all homes of the study, the average number of rooms to a household was 3.63.

Furniture and equipment. The amount and value of furnishings and equipment that a household has is an indication of the degree of comfort enjoyed. In modest homes such as are here described, furnishings and equipment are usually meager and obviously in harmony with the size and type of houses. Usually, these consisted of a few chairs or stools, a bench, a table, native kitchen utensils, a few pieces of china and silver ware, one or two kerosene lamps, some framed religious pictures, a mirror, a trunk, a bamboo bed, and in many homes a sewing machine. It was not uncommon to find homes without chairs and tables, a bench being the only furniture in evidence. For all families of this study, the average value of furniture and equipment was ₱123.69 to a home. Comparing the figures by tenure groups, the average value of furnishings and equipment in owner homes was ₱150.08; in part owner homes, ₱93.91; and in tenant homes, ₱45.09. There is observed a sudden drop in values, and, therefore, extent, of furnishings and equipment from owner to tenant homes.

Home conveniences. Home conveniences in this study included water-pipe connections, bathrooms, toilets near or in the house and electric lighting. Those familiar with farm or barrio life in the Islands will at once understand that many of these home conveniences are unknown, those depending on water system and electric power will remain unknown until these public utilities become more numerous. Regardless of tenure, neither the farm families of Camiling nor those of Mangatarem had any of these home conveniences.

Surprise may be expressed at the absence of even toilets as a home convenience. Those familiar with the construction of small farm homes will at once understand that toilets are not usually built in the house or very near it; usually, if one is provided, it is a ramschackle affair at some distance from the house. Such toilets were not included in this study as a home convenience. There was a water system in Mendez Nuñez but only eight families of the study had water-pipe connections and bathrooms in their homes. Four homes in Amadeo had bathrooms and toilets. Only Mendez Nuñez had a water system. In none of the four municipalities was there an electric light system.

Value of the house. As a final index of the level of living as judged by the character of the homes, the value of the houses is also shown in table 5. Owner homes averaged highest, the value being ₱577.08; part owner homes, averaged ₱293.97; and tenant homes, averaged lowest, being, ₱219.78. It will be seen that the values for Mendez Nuñez and Amadeo in all tenures were relatively higher than for the corresponding houses in Mangatarem and Camiling. An explanation for this was found in that many homes in the two Cavite towns were built during the boom times produced by the world war and post-war conditions when the prices for their once principal money crop, abacá, were high. Hence, these house values do not reflect accurately the present social and economic status of the farm families surveyed.

Cost of living

The cost of living of a family as shown by the value of all goods used for a given period measures the standard of living of the family. It is the objective measure of the sum of satisfactions enjoyed by the family. Table 6a shows the average value of all goods used by the 240 farm families for one year and the distribution of this value among the principal groups of goods furnished by the farm and those purchased. The table is further arranged to show the value of the goods used by tenure classes. Table 6b shows the distribution of this value among the different groups of goods used in percentages. Likewise, the proportion of the goods which the farm has furnished and that which was purchased for the different groups of goods is shown.

The average value of all goods used for all tenures and for all municipalities was ₱529.10 a household of 5.66 persons. Farm families of Mendez Nuñez had the highest average value of all goods used, which was ₱715.30 a household of 6.28 persons and Mangata-

rem families the lowest, being ₱349.80 a household of 5.43 persons. One obvious cause for this variation is found in the size of households, being highest for Mendez Nuñez and lowest for Mangatarem.

Considered by tenure classes, table 6a shows that the average value of all goods used was highest for owner families, being ₱586.50 a household of 5.51 persons; and lowest for tenant families, being ₱412.00 a household of 5.48 persons. The extent to which the farm contributed to supply the family directly with the goods that it has used is shown in tables 6a and 6b. The rôle played by the farm in this respect was a very important one. Thus for all families of the study regardless of tenure classes, of ₱529.10, an average total value of all goods used, ₱241.50 or 45.6 per cent came directly from the farm. Considered by tenure classes, it was found that of ₱586.50, an average total value of all goods used by owner families, ₱254.60 or 43.4 per cent was furnished by the farm; by part owner families, of ₱448.80, ₱229.60 or 51.2 per cent; and by tenant families, of ₱412.00, ₱188.70 or 45.8 per cent. It appears from these figures that the proportion furnished by the farm of the value of all goods used was lowest for owner families and highest for part owner families. The proportion of all goods furnished by the farm in all tenures, however, was so high that it was almost one-half of the value of all goods used. The distribution of the value of all goods used among the different groups to which they were classified is treated separately in the following discussions.

Food. The value of food used by all families of the study constituted the largest single item of family expenditure. The value for all families, regardless of tenure, was ₱283.70 a household or 53.6 per cent of the value of all goods used. The farm was drawn on heavily for this item as 61.7 per cent of the value of food used was furnished directly by it. The principal items of food contributed by the farm to the household were rice, other cereals as corn, vegetables, a very limited quantity of live stock products, mainly eggs and poultry and pork. Considered by tenures, the average value of food consumed by owner families was ₱296.00 a household or 50.5 per cent of the value of all goods used; by part owner families, ₱271.30 a household or 60.5 per cent; and by tenant families, ₱239.00 a household or 58 per cent. Owner families, therefore, consumed relatively less food than did part owner and tenant families.

It is readily apparent from the figures on food consumed that the food of the farm families of the study was simple, if not meager. It was, indeed, found to be true that great economy was practiced in the consumption of food materials. During the months between

planting and harvesting, the people in general subsisted largely on rice and a very limited amount of fish. Meat was rarely an item in the diet. In Amadeo, for example, there was no regular butcher. The farmers raised, however, vegetables, such as beans, tomatoes, gabi, squash, and fruits as papaya, and pineapple.

Clothing. The cost of clothing for the families included all items of apparel as clothes, hats, shoes, slippers and the like. All expenses for sewing and mending or repair and the materials used were included under this class of expenditure. The average value of clothing for all families of the study, regardless of tenure classes, was ₱37.20 a family or 7 per cent of the total cost of living. Considered by tenure classes, owner families spent, on an average, ₱39.30 a family or 6.7 per cent of the total cost of living; part owner families, ₱32.80 or 7. 3 per cent; and tenant families, ₱39.00 or 9.5 per cent. Records obtained show that farm families of the study usually purchased their clothes before harvest time and before Christmas.

Housing. The cost of housing furnished by the farm was arrived at by figuring an annual charge of 10 per cent for rent on the value of the house. The value of the house in turn was arrived at after an estimate made by the owner was checked for accuracy by the investigator in so far as it was possible, considering such factors as size, materials used, and general condition. For all families of the study, the cost of housing furnished by the farm averaged ₱45.90 a family or 8.7 per cent of the value of all goods used. Comparing the cost of housing of the farm families by tenure groups, it was found that the cost for owner families averaged ₱57.70 a family or 9.8 per cent of the total cost of living; for part owner families, ₱29.40 or 6.6 per cent; and for tenant families, ₱22.00 or 5. 3 per cent. The cost of housing, therefore, averaged relatively highest for owner families, and lowest for tenant families.

Furnishings and equipment. For all families of the study, the average value of furnishings and equipment purchased during the year was ₱6.50 a family or 1.2 per cent of the total cost of living. Comparing the figures obtained for this item by tenure classes, it was found that the average value for owner families was ₱6.40 a family or 1.1 per cent of the value of all goods used; for part owner families, ₱6.50 or 1.4 per cent; and for tenant families, ₱6.60 or 1.6 per cent. The figures, therefore, varied slightly among families under different tenure classes.

Operation goods. Expenditures for operation included the value of fuel consumed, and the amount spent for petroleum, matches, laundry supplies as soap, starch and charcoal, water where it was

purchased and transportation in connection with the household business. Water except in Mendez where it was furnished by a water system, is a free commodity in towns and barrios. Well water is easily obtainable. A group of homes usually coöperate to dig a well for the common use of their members. As water is never bought save where it is supplied from a central system, no value can be attached to it. The average expenditures for operation goods for all families of the study was ₱42.40 a family or 8 per cent of the total value of all goods used. Of this amount, ₱13.70 or 32.3 per cent was furnished directly by the farm. This item consisted largely of fuel which is easily obtainable in relative abundance so that its cost was nominal.

Considered by tenure classes, it was found that the average value of operation goods for owner families was ₱46.50 a family or 7.9 per cent; for part owner families, ₱37.50 or 8.4 per cent; and for tenant families, ₱31.30 or 7.6 per cent. The proportion of these values for operation goods which was furnished by the farm was for the respective tenure groups as follows: 30.1 per cent for owner families; 36.5 per cent for part owner families; and 39.3 per cent for tenant families. The value of operation goods used varied very little among farm families under different tenure classes. Among the principal articles listed under operation which were purchased by the farm family were petroleum, soap, and matches. Starch is easily made on the farm. The most rigid economy, especially in the use of petroleum and matches, was practiced in every home.

Maintenance of health. Expenses for the maintenance of health among the 240 farm families studied were confined to the purchase of medicines, usually household remedies, and in very rare cases for the payment of services of physicians, dentists, and oculists. Conditions of barrio and farm life are such that the people, because physicians are rarely available, and also because of the relatively low incomes earned, resort to the services of healers or *practicantes*. Mendez Nuñez and Amadeo had no drug store and there was no resident physician or dentist. Camiling and Mangatarem were better in this respect because they had drug stores and resident physicians. Even then, barrio residents are often so far from the town proper that physicians are hardly within call and the fees are relatively high. Through the Philippine Bureau of Health, essential preventive health measures as vaccination are performed by health inspectors in the different municipalities. It was then no surprise that the expense for the maintenance of health was small, the average for all families of the study was ₱6.80 a family or 1.3 per cent

of the value of all goods used. The expense by tenure groups was almost the same. For owner families, it was ₱7.70 a family or 1.3 per cent; for part owner families, ₱5.60 or 1.2 per cent; and for tenant families, ₱5.40 or 1.3 per cent.

Advancement. The expenses for advancement cover all expenditures for the cultural improvement or the refinement of the family. The principal items that were found to come under this group were the expenses for the formal education of children as fees, books, school supplies, board and lodging of children away from home and attending school, expenses for religious celebrations and social gatherings in connection with weddings, christenings, and other occasions. The largest single item under advancement was the expenditure for the education of children. It is a matter of common observation that even the poorest family would undergo many personal sacrifices to be able to send the children to school. So strong has this hunger for education become that attendance in public schools is only limited by the size of the school building and the teaching personnel. The next item of importance under advancement was the expenditures incurred for social gatherings, these are known as "fiestas" usually held on the occasion of important events as a wedding in the family or a christening and on the religious feast day of the barrio or town. Harvest is also usually an occasion for festive gatherings and all these, as they are relatively extravagant, make deep inroads into the small income of the farm family.

For all families of the study, the average expenditure for advancement was ₱65 a family or 12.3 per cent of the value of all goods used. Compared by tenure classes, owner families spent an average of ₱88.30 a family or 15. 1 per cent of the total cost of living; part owner families, ₱27.50 or 6.1 per cent; and tenant families, ₱36.50 or 8.9 per cent. Owner families spent, therefore, very much more for advancement than families in other tenures. A large part of this high average for owner families is due to the unusually high expenditure of owner families of Mendez Nuñez. The very high figure for this municipality was largely due to the heavy expenditures of families in sending their children to a rural high school located in a neighboring municipality.

Personal goods. Personal goods included all values of goods for personal uses as tobacco, jewelry, toilet articles and services of barber. These constituted a relatively important item in the family budget. This is not surprising, however, in view of the fact that the average family is not only a large user of tobacco in all its forms but also shows great fondness for jewelry. This fondness for jewelry

is widespread and often such articles constitute the only form of savings of a family. It will be observed that for Mendez Nuñez and Amadeo a large portion of these personal goods was supplied by the farm, being 31.1 per cent and 43.5 per cent, respectively. This was due to the fact that these farmers raised their own tobacco for home consumption.

The average value of personal goods used by all families was ₱30.50 a family or 5.8 per cent of the value of all goods consumed. Compared by tenure groups, the relative figures were almost the same. Thus owner families spent an average of ₱32.60 a family or 5.6 per cent of the total cost of living; part owner families, ₱28.20 or 6.3 per cent; and tenant families, ₱23.90 or 5.8 per cent.

Others. This final group included values of all goods which could not be properly classified under any of the classes listed. Taxes were included under this item as the amounts in most cases were too small to warrant a separate classification. For all families of the study, the average value of goods under this group was ₱11.10 a family or 2.1 per cent. The relative expenditures by families under different tenure groups classified under this item was almost identical.

SUMMARY

1. Included in this study were 240 farm families equally distributed among four municipalities; namely, Mendez Nuñez and Amadeo, Cavite; Mangatarem, Pangasinan; and Camiling, Tarlac.

2. Classified by tenure classes, of the 240 farm families, 145 were farm owners; 76, part owners; and 19, tenants. Peasant proprietorship was found general and tenancy was observed to be relatively unimportant.

3. Families included in the study were working on farms of small areas ranging in the great majority of cases from less than 1 hectare to 3 hectares in area. This, therefore, would mean that the results here reported are intended to picture a standard of living on the farm near the minimum.

4. For all families of the study, the average number of persons to a family was 5.12 and to a household, 5.65. The average size of families was very nearly the same in all municipalities and in all tenures.

5. Considering all families of the study, of the members of the household 10 years and above, 58.90 per cent was literate in vernacular; 50.98 per cent, in English; and 2.59 per cent, in Spanish. The

high percentages of literacy in English in all municipalities surveyed were due to the opening of public and free elementary schools during the last thirty years.

6. The extent of formal education received by the children of the 240 farm families was shown to be as follows: Of a total of 783 children, 555 or 70.88 per cent were of school age. Of the 555 children of school age, 91.71 per cent had attended or were in school at the time of survey, thus showing a high percentage of children having received the benefit of some education. Nearly 60 per cent of all children of school age received only a primary education, that is, no higher than the fourth grade; about 30 per cent had intermediate school attainments; and a little over 10 per cent had high school and collegiate education. Of the latter, more than one-half had only from one to two years in a secondary school. Considered by tenure classes, the extent of formal education received by children was lowest among tenant families and highest among owner families.

7. Ownership of the home was general, as shown by the fact that 222 of the 240 farm families owned their homes. As measures of the level of living, or the degree of comfort and satisfaction that may be derived by the farm family from its home, the factors considered were value of the house, kind of construction, size as shown by number of rooms, value of furnishings and equipment, and home conveniences. The results showed the following:

(*a*) In value owner homes averaged highest and tenant homes lowest.

(*b*) In kind of construction, owner homes were of better material and better built than those of other tenure groups.

(*c*) Homes of owner families were largest and those of tenant families, smallest, although differences in number of rooms per household were too small to be of much significance.

(*d*) The value of furnishings and equipment was highest in owner homes and lowest in tenant homes, the differences being fairly large.

(*e*) Homes of families in all tenures and in all municipalities were devoid of home conveniences as electric lighting, water system, toilets and bathrooms.

8. For all families of the study, the average value of all goods used during one year was ₱529.10 to a household of 5.66 persons. Considered by tenure classes, the value of all goods used was highest for owner families which was ₱586.50 to a household of 5.51 persons;

and lowest for tenant families which was ₱412.00 to a hous
5.48 persons. It was thus observed that owner families h
highest cost of living and tenant families, the lowest.

9. The extent to which the farm contributed to supply the fan directly with the goods that it used was very great. Thus for a families of the study, 45.6 per cent of the total value of goods usec which was ₱529.10 to a household came directly from the farm. Chief among these goods that were supplied by the farm were food, housing, operation goods and personal goods.

10. For all families of the study, of a total value of all goods used to a household of ₱529.10, 53.6 per cent was spent for food; 7 per cent, for clothing; 8.7 per cent, for housing; 1.2 per cent, for furnishings and equipment; 8 per cent, for operation goods; 1.3 per cent, for the maintenance of health; 12.5 per cent, for advancement; 5.8 per cent, for personal goods; and 2.1 per cent, for others.

11. Considered by tenure classes the expenditures for the different groups of goods showed the following:

(*a*) The value of food used was relatively less for owner families than for those of other tenures.

(*b*) The outlay for clothing in pesos was almost the same for all tenure groups, although in percentage of total value of goods used, tenant families spent relatively more than did families under other tenures.

(*c*) Cost of housing furnished by the farm was relatively highest for owner families and lowest for tenant families.

(*d*) The expenditures for furnishings and equipment varied very little among families under different tenure classes.

(*e*) The value of operation goods used varied very little among families under different tenure groups.

(*f*) The relative expense for the maintenance of health by families in different tenures was almost the same.

(*g*) Owner families spent relatively much more for advancement than did those of other tenure groups.

(*h*) The relative expense for personal goods by families in different tenure groups was almost the same.

12. Within the limits of the work here reported, it becomes apparent that the life on peasant farms is one of poverty and drudgery. Any program of rural improvement should include not only the effort to increase the farmer's income, but also a plan that would bring about a kind of life on the farm that is more attractive, freer from drudgery, fuller of opportunity, happier, and more comfortable.

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TABLE 1

Size of family and size of household; 240 farm families of Mendez Nuñez and Amadeo, Cavite; Mangatarem, Pangasinan; and Camiling, Tarlac

ITEM	ALL TOWNS 240 FAMILIES		MENDEZ 60 FAMILIES		AMADEO 60 FAMILIES		MANGATAREM 60 FAMILIES		CAMILING 60 FAMILIES	
	number	*average*	*number*	*average*	*number*	*average*	*number*	*average*	*number*	*average*
Size of family	1230	5.12	332	5.50	288	4.80	306	5.10	304	5.07
Children at home	731	3.04	200	3.33	171	2.85	182	3.03	178	2.91
Children not at home	52	0.21	20	0.33	7	0.12	10	0.17	15	0.25
Other people in the home	128	0.53	44	0.73	40	0.66	20	0.33	24	0.40
Size of household	1358	5.65	376	6.28	328	5.47	326	5.43	328	5.47

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TABLE 2

Number of children in various age groups; 240 farm families of Mendez Nuñez and Amadeo, Cavite; Mangatarem, [illegible]sinan; and Camiling, Tarlac

AGE GROUPS	ALL FAMILIES			MENDEZ NUÑEZ			AMADEO			MANGATAREM			CAMILING		
	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female
Under 1 year	34	19	15	9	4	5	10	6	4	10	4	6	5	5	—
1 to 2 years ...	32	15	17	10	5	5	5	2	3	11	6	5	6	2	4
2 to 3 years ...	28	10	18	7	2	5	5	3	2	8	1	7	8	4	4
3 to 4 years ...	32	17	15	6	3	3	7	2	5	8	5	3	11	7	4
4 to 5 years ...	37	22	15	9	5	4	9	3	6	12	10	2	7	4	3
5 to 6 years ...	28	15	13	6	2	4	9	5	4	6	3	3	7	5	2
6 to 7 years ...	37	14	23	8	2	6	11	3	8	5	4	1	13	5	8
7 to 8 years ...	36	19	17	7	4	3	8	3	5	13	8	5	8	4	4
8 to 9 years ...	36	20	16	13	6	7	7	4	3	8	6	2	8	4	4
9 to 10 years ...	21	10	11	8	4	4	5	4	1	5	1	4	3	1	2
10 to 11 years ...	38	15	23	8	3	5	8	2	6	11	6	5	11	4	7
11 to 12 years ...	16	10	6	2	1	1	4	4	—	4	1	3	6	4	2
12 to 13 years ...	41	22	19	13	7	6	6	2	4	9	7	2	13	6	7
13 to 14 years ...	31	19	12	9	6	3	8	6	2	4	1	3	10	6	4
14 to 15 years ...	37	18	19	9	6	3	8	5	3	12	4	8	8	3	5
15 to 16 years ...	37	15	22	13	6	7	6	1	5	8	3	5	10	5	5
16 to 17 years ...	43	22	21	12	5	7	11	6	5	8	3	5	12	8	4
17 to 18 years ...	26	12	14	7	4	3	7	5	2	4	2	2	8	1	7
18 to 19 years ...	42	21	21	10	8	2	9	7	2	13	2	11	10	4	6
19 to 20 years ...	27	15	12	7	4	3	9	7	2	6	2	4	5	2	3
20 to 21 years ...	27	13	14	9	3	6	8	4	4	5	5	—	5	1	4
21 to 22 years ...	21	14	7	7	6	1	3	2	1	7	4	3	4	2	2
22 to 23 and over.	76	43	33	31	21	10	15	7	8	15	7	8	15	8	7
Totals ..	783	400	383	220	117	103	178	93	85	192	95	97	193	95	98

TABLE 3

Literacy of household members; 240 farm families of Mendez Nuñez and Amadeo, Cavite; Mangatarem, Pangasinan; and Camiling, Tarlac

	ALL FAMILIES		MENDEZ NUÑEZ		AMADEO		MANGATAREM		CAMILING	
	number	*per cent*	*number*	*per cent*	*number*	*per cent*	*number*	*per cent*	*number*	*per cent*
Literate in vernacular	526	58.90	203	70.24	164	70.00	89	37.08	70	27.78
Literate in English	508	50.98	121	41.87	109	45.42	121	50.42	157	62.30
Literate in Spanish	24	2.59	10	3.45	4	1.70	4	1.67	6	2.38

TABLE 4

Extent of formal education received by children of 240 farm families of Mendez Nuñez and Amadeo, Cavite; Mangatarem, Pangasinan; and Camiling, Tarlac

FAMILIES	ALL CHILDREN	OF SCHOOL AGE		ATTENDED SCHOOL		EXTENT OF FORMAL EDUCATION: Attended private Catholic School		Fourth grade or less		Seventh grade or less	
		number	*per cent*	*number*	*per cent*	*number*	*per cent*	*number*	*per cent*	*number*	*per cent*
All families	783	555	70.88	509	91.71	47	9.23	243	47.74	150	29.47
Mendez	220	165	75.00	151	91.62	22	14.57	56	37.09	47	31.13
Amadeo	178	122	68.54	112	91.80	—	—	65	58.03	33	29.46
Mangatarem	192	132	68.75	119	90.15	19	15.97	70	58.82	21	17.65
Camiling	193	136	70.47	127	93.38	6	4.72	52	40.95	49	38.58
Owner families	447	315	70.46	294	93.33	15	5.10	127	43.20	93	31.63
Mendez	94	73	77.66	67	91.78	7	10.45	21	31.34	18	26.87
Amadeo	152	104	68.42	96	92.31	—	—	54	56.25	28	29.17
Mangatarem	71	46	64.79	41	89.13	7	17.07	18	43.90	11	26.83
Camiling	130	92	70.77	90	97.83	1	1.11	34	37.78	36	40.00
Part-owner families ...	275	189	68.72	168	88.88	25	14.88	91	54.16	44	26.19
Mendez	99	69	69.70	64	92.75	10	15.62	26	40.64	25	39.06
Amadeo	26	18	69.23	16	88.89	—	—	11	68.75	5	31.25
Mangatarem	105	72	68.57	64	88.89	11	17.19	42	65.62	7	10.94
Camiling	45	30	66.67	24	80.00	4	16.66	12	50.00	7	29.17
Tenant families	61	51	83.60	47	92.15	7	14.89	25	53.19	13	27.66
Mendez	27	23	85.19	20	86.96	5	25.00	9	45.00	4	20.00
Amadeo	—	—	—	—	—	—	—	—	—	—	—
Mangatarem	16	14	87.50	14	100.00	1	7.14	10	71.43	3	21.43
Camiling	18	14	77.78	13	92.86	1	7.70	6	46.15	6	46.15

TABLE 4 (Continued)

FAMILIES	ALL CHILDREN	EXTENT OF FORMAL EDUCATION									
		1 - 2 years in High School		3 - 4 years in High School		High school graduate		1 - 4 years in College		College graduate	
		number	*per cent*	*number*	*per cent*	*number*	*per cent*	*number*	*per cent*	*number*	*per cent*
All families	783	31	6.09	21	4.13	5	0.98	9	1.77	3	0.59
Mendez	220	6	3.97	8	5.30	5	3.31	4	2.65	3	1.98
Amadeo	178	7	6.25	6	5.36	—	—	1	0.90	—	—
Mangatarem	192	7	5.88	2	1.68	—	—	—	—	—	—
Camiling	193	11	8.66	5	3.94	—	—	4	3.15	—	—
Owner families	447	25	8.51	20	6.80	4	1.36	8	2.72	2	0.68
Mendez	94	5	7.46	7	10.45	4	5.96	3	4.48	2	2.99
Amadeo	152	7	7.29	6	6.25	—	—	1	1.04	—	—
Mangatarem	71	3	7.32	2	4.88	—	—	—	—	—	—
Camiling	130	10	11.11	5	5.56	—	—	4	4.44	—	—
Part-owner families ...	275	5	2.97	1	0.60	1	0.60	1	0.60	—	—
Mendez	99	—	—	1	1.56	1	1.56	1	1.56	—	—
Amadeo	26	—	—	—	—	—	—	—	—	—	—
Mangatarem	105	4	6.25	—	—	—	—	—	—	—	—
Camiling	45	1	4.17	—	—	—	—	—	—	—	—
Tenant families	61	1	2.13	—	—	—	—	—	—	1	2.13
Mendez	27	1	5.00	—	—	—	—	—	—	1	5.00
Amadeo	—	—	—	—	—	—	—	—	—	—	—
Mangatarem	16	—	—	—	—	—	—	—	—	—	—
Camiling	18	—	—	—	—	—	—	—	—	—	—

TABLE 5

The value of houses and house furnishings, ownership, construction materials, home conveniences, and number of rooms per household; 240 farm families of Mendez Nuñez and Amadeo, Cavite; Mangatarem, Pangasinan; and Camiling, Tarlac

FAMILIES	HOMES STUDIED	STATUS OF POSSESSION OF FARM HOMES			MATERIALS USED IN THE CONSTRUCTION OF HOUSES			HOME CONVENIENCES		AV. SIZE OF HOUSEHOLD	AV. NUMBER OF ROOMS PER HOUSEHOLD	AV. VALUE OF HOUSE IN PESOS	AV. VALUE OF FURNISHINGS AND EQUIPMENT IN PESOS
		Owned	No rental	Rented	Strong	Mixed	Light	With	Without				
All families	240	222	18	—	63	101	76	12	228	5.66	3.63	459.15	123.69
Mendez	60	55	5	—	41	19	—	8	52	6.28	3.47	739.58	153.62
Amadeo	60	56	4	—	17	37	6	4	56	5.47	3.32	455.51	117.76
Mangatarem .	60	63	7	—	—	19	41	—	60	5.43	3.54	175.55	72.51
Camiling	60	58	2	—	5	26	29	—	60	5.47	4.20	465.97	150.87
Owner families ..	145	139	6	—	43	71	31	12	133	5.51	3.83	577.08	150.08
Mendez	26	24	2	—	22	4	—	8	18	6.12	4.00	1037.66	200.35
Amadeo	52	48	4	—	16	31	5	4	48	5.50	3.38	485.90	125.34
Mangatarem .	25	25-	—	—	—	11	14	—	25	5.16	3.52	194.76	92.72
Camiling	42	42	—	—	5	25	12	—	42	5.36	4.45	632.48	183.73
Part-owner families	76	72	4	—	19	22	35	—	76	6.00	3.34	293.97	93.91
Mendez	26	26	—	—	18	8	—	—	26	6.50	3.10	546.96	137.50
Amadeo	8	8	—	—	1	6	1	—	8	5.25	2.88	258.00	68.54
Mangatarem .	31	27	4	—	—	7	24	—	31	5.61	3.52	161.42	60.10
Camiling	11	11	—	—	—	1	10	—	11	6.45	3.72	95.73	104.63
Tenant families ..	19	11	8	—	1	8	10	—	19	5.48	3.23	219.78	45.09
Mendez	8	5	3	—	1	7	—	—	8	6.13	2.80	396.85	62.86
Amadeo	—	—	—	—	—	—	—	—	—	—	—	—	—
Mangatarem .	4	1	3	—	—	1	3	—	4	5.75	3.75	165.00	42.35
Camiling	7	5	2	—	—	—	7	—	7	4.57	3.43	48.71	26.34

TABLE 6a

The average value of goods used during one year and the distribution of this value among the principal groups of goods furnished by the farm and purchased; 240 farm families of Mendez Nuñez and Amadeo, Cavite; Mangatarem, Pangasinan; and Camiling, Tarlac

TENURE GROUPS AND TOWNS	FAMILIES STUDIED	SIZE OF HOUSEHOLD	ALL GOODS USED			FOOD			CLOTHING	HOUSING FURNISHED BY FARM	FURNISHINGS AND EQUIPMENT
			Total	Furnished by farm	Purchased	Total	Furnished by farm	Purchased			
	number	*persons*	*pesos*	*pesos*	*pesos*	*pesos*	*pesos*	*pesos*	*pesos*	*pesos*	*pesos*
Owners, part-owners, and tenants:											
All towns	240	5.66	529.10	241.50	287.60	283.70	175.10	108.60	37.20	45.90	6.50
Mendez	60	6.28	715.30	322.20	393.10	321.10	216.40	104.70	64.00	74.00	10.90
Amadeo	60	5.47	565.90	279.60	286.30	309.10	200.30	108.80	39.90	45.50	5.90
Mangatarem	60	5.43	349.80	172.90	176.90	227.10	147.10	80.00	16.80	17.60	5.10
Camiling	60	5.47	485.40	191.20	294.20	277.20	136.60	140.60	28.20	46.60	4.00
Owners: All towns	145	5.51	586.50	254.60	331.90	296.00	175.70	120.30	39.30	57.70	6.40
Mendez	26	6.12	872.70	334.20	538.50	320.00	200.90	119.10	72.30	103.80	11.40
Amadeo	52	5.50	579.80	284.70	295.10	312.60	202.50	110.10	40.50	48.60	6.00
Mangatarem	25	5.16	363.10	172.70	190.40	231.20	145.40	85.80	14.00	19.50	6.00
Camiling	42	5.36	550.70	216.70	334.00	299.00	145.00	154.00	32.40	63.30	4.20
Part-owners: All towns	76	6.00	448.80	229.60	219.20	271.30	180.70	90.60	32.80	29.40	6.50
Mendez	26	6.50	616.10	323.90	292.20	334.10	236.10	98.00	59.10	54.70	10.30
Amadeo	8	5.25	475.80	246.70	229.10	286.40	186.00	100.40	35.70	25.80	5.40
Mangatarem	31	5.61	329.30	171.10	158.20	222.80	146.80	76.00	14.00	16.10	4.80
Camiling	11	6.45	370.40	159.40	211.00	248.40	141.40	107.00	21.60	9.60	3.00
Tenants: All towns	19	5.48	412.00	188.70	223.30	239.00	148.20	90.80	39.00	22.00	6.60
Mendez	8	6.13	526.20	277.50	248.70	282.50	203.00	79.50	53.30	39.70	10.90
Amadeo	—	—	—	—	—	—	—	—	—	—	—
Mangatarem	4	5.75	425.10	187.50	237.60	234.60	160.00	74.60	55.40	16.50	2.40
Camiling	7	4.57	274.10	88.00	186.10	191.60	78.70	112.90	13.40	4.90	4.00

TABLE 6a (Continued)

TENURE GROUPS AND TOWNS	FAMILIES STUDIED	SIZE OF HOUSE-HOLD	OPERATION GOODS			HEALTH	AD-VANCE-MENT	PERSONAL GOODS			OTHERS
			Total	Fur-nished by farm	Pur-chased			Total	Fur-nished by farm	Pur-chased	
	number	*persons*	*pesos*	*pesos*	*pesos*	*pesos*	*pesos*	*pesos*	*pesos*	*pesos*	*pesos*
Owners, part-owners, and tenants:											
All towns	240	5.66	42.40	13.70	28.70	6.80	65.00	30.50	6.70	23.80	11.10
Mendez	60	6.28	61.50	20.70	40.80	8.10	124.40	35.70	11.10	24.60	15.60
Amadeo	60	5.47	41.90	18.10	23.80	5.70	67.10	36.10	15.70	20.40	14.70
Mangatarem	60	5.43	25.80	8.20	17.60	2.50	24.80	22.80	—	22.80	7.30
Camiling	60	5.47	40.50	7.90	32.60	11.00	43.70	27.40	—	27.40	6.80
Owners: All towns	145	5.51	46.50	14.00	32.50	7.70	88.30	32.60	7.20	25.40	12.00
Mendez	26	6.12	73.80	20.50	53.30	8.70	229.20	36.90	9.00	27.90	16.60
Amadeo	52	5.50	42.30	18.10	24.20	6.10	73.10	35.90	15.50	20.40	14.70
Mangatarem	25	5.16	26.40	7.80	18.60	2.40	29.60	24.20	—	24.20	9.80
Camiling	42	5.36	46.60	8.40	38.20	12.20	55.00	30.80	—	30.80	7.20
Part-owners: All towns	76	6.00	37.50	13.70	23.80	5.60	27.50	28.20	5.90	22.30	10.00
Mendez	26	6.50	55.50	21.10	34.40	8.70	43.10	35.30	12.00	23.30	15.30
Amadeo	8	5.25	39.00	17.80	21.20	3.40	27.80	37.80	17.10	20.70	14.50
Mangatarem	31	5.61	25.20	8.20	17.00	2.40	17.00	22.20	—	22.20	4.80
Camiling	11	6.45	28.20	8.40	19.80	8.60	20.20	21.60	—	21.60	9.20
Tenants: All towns	19	5.43	31.30	12.30	19.00	5.40	36.50	23.90	6.30	17.60	8.30
Mendez	8	6.13	40.80	19.90	20.90	4.50	48.00	33.00	14.90	18.10	13.50
Amadeo	—	—	—	—	—	—	—	—	—	—	—
Mangatarem	4	5.75	26.60	11.00	15.60	3.60	55.40	19.20	—	19.20	11.40
Camiling	7	4.57	23.20	4.40	18.80	7.60	12.60	16.20	—	16.20	.60

TABLE 6b

Percentage distribution

TENURE GROUPS AND TOWNS	FAMILIES STUDIED	SIZE OF HOUSE-HOLD	ALL GOODS USED			FOOD			CLOTH-ING	HOUS-ING FUR-NISHED BY FARM	FUR-NISH-INGS AND EQUIP-MENT
			Total	Fur-nished by farm	Pur-chased	Total	Fur-nished by. farm	Pur-chased			
	number	*persons*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
Owners, part-owners, and tenants:											
All towns	240	5.66	100.0	45.6	54.4	53.6	61.7	38.3	7.0	8.7	1.2
Mendez	60	6.28	100.0	45.0	55.0	44.9	67.4	32.6	9.0	10.3	1.5
Amadeo	60	5.47	100.0	49.4	50.6	54.6	64.8	35.2	7.1	8.0	1.0
Mangatarem	60	5.43	100.0	49.4	50.6	64.9	64.8	35.2	4.8	5.0	1.5
Camiling	60	5.47	100.0	39.4	60.6	57.1	49.3	50.7	5.8	9.6	0.8
Owners: All towns	145	5.51	100.0	43.4	56.6	50.5	59.4	40.6	6.7	9.8	1.1
Mendez	26	6.12	100.0	38.3	61.7	36.7	62.8	37.2	8.3	11.9	1.3
Amadeo	52	5.50	100.0	49.1	50.9	53.9	64.8	35.2	7.0	8.4	1.0
Mangatarem	25	5.16	100.0	47.6	52.4	63.7	62.9	37.1	3.8	5.4	1.6
Camiling	42	5.36	100.0	39.3	60.7	54.3	48.5	51.5	5.9	11.5	0.8
Part-owners: All towns	76	6.00	100.0	51.2	48.8	60.5	66.6	33.4	7.3	6.6	1.4
Mendez	26	6.50	100.0	52.6	47.4	54.2	70.7	29.3	9.6	8.9	1.7
Amadeo	8	5.25	100.0	51.8	48.2	60.2	65.0	35.0	7.5	5.4	1.1
Mangatarem	31	5.61	100.0	52.0	48.0	67.7	65.9	34.1	4.3	4.9	1.4
Camiling	11	6.45	100.0	43.0	57.0	67.1	56.9	43.1	5.8	2.6	0.8
Tenants: All towns	19	5.48	100.0	45.8	54.2	58.0	62.0	38.0	9.5	5.3	1.6
Mendez	8	6.13	100.0	52.7	47.3	53.7	71.9	28.1	10.1	7.5	2.1
Amadeo	—	—	—	—	—	—	—	—	—	—	—
Mangatarem	4	5.75	100.0	44.1	55.9	55.2	68.2	31.8	13.0	3.9	0.6
Camiling	7	4.57	100.0	32.1	67.9	69.9	41.1	58.9	4.9	1.8	1.4

TABLE 6b (Continued)

TENURE GROUPS AND TOWNS	FAMILIES STUDIED	SIZE OF HOUSE-HOLD	OPERATION GOODS: Total	OPERATION GOODS: Furnished by farm	OPERATION GOODS: Purchased	HEALTH	AD-VANCE-MENT	PERSONAL GOODS: Total	PERSONAL GOODS: Furnished by farm	PERSONAL GOODS: Purchased	OTHERS
	number	*persons*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
Owners, part-owners, and tenants:											
All towns	240	5.66	8.0	32.3	67.7	1.3	12.3	5.8	22.0	78.0	2.1
Mendez	60	6.28	8.6	33.7	66.3	1.1	17.4	5.0	31.1	68.9	2.2
Amadeo	60	5.47	7.4	43.2	56.8	1.0	11.9	6.4	43.5	56.5	2.6
Mangatarem	60	5.43	7.4	31.8	68.2	0.7	7.1	6.5	—	100.0	2.1
Camiling	60	5.47	8.3	19.5	80.5	2.3	9.0	5.7	—	100.0	1.4
Owners: All towns	145	5.51	7.9	30.1	69.9	1.3	15.1	5.6	22.1	77.9	2.0
Mendez	26	6.12	8.4	27.8	72.2	1.0	26.3	4.2	24.4	75.6	1.9
Amadeo	52	5.50	7.3	42.8	57.2	1.1	12.6	6.2	43.2	56.8	2.5
Mangatarem	25	5.16	7.3	29.5	70.5	0.7	8.1	6.7	—	100.0	2.7
Camiling	42	5.36	8.4	18.0	82.0	2.2	10,0	5.6	—	100.0	1.8
Part-owners: All towns	76	6.00	8.4	36.5	63.5	1.2	6.1	6.3	20.9	79.1	2.2
Mendez	26	6.50	9.0	38.0	62.0	1.4	7.0	5.7	34.0	66.0	2.5
Amadeo	8	5.25	8.2	45.6	54.4	0.7	5.9	7.9	45.2	54.8	3.1
Mangatarem	31	5.61	7.7	32.5	67.5	0.7	5.2	6.7	—	100.0	1.4
Camiling	11	6.45	7.6	29.8	70.2	2.3	5.5	5.8	—	100.0	2.5
Tenants: All towns	19	5.48	7.6	39.3	60.7	1.3	8.9	5.8	26.4	73.6	2.0
Mendez	8	6.13	7.7	48.8	51.2	0.9	9.1	6.3	45.2	54.8	2.6
Amadeo	—	—	—	—	—	—	—	—	—	—	—
Mangatarem	4	5.75	6.3	41.4	58.6	0.8	13.0	4.5	—	100.0	2.7
Camiling	7	4.57	8.5	19.0	81.0	2.8	4.6	5.9	—	100.0	0.2

EFFECTS ON THE GROWTH AND DEVELOPMENT OF SUGAR CANE PLANT OF BAGASSE WHEN ADDED TO SOIL IN POTS [1]

ARTEMIO P. MALABAYABAS

WITH FOUR TEXT FIGURES

INTRODUCTION

Bagasse, a by-product of the cane sugar industry, is usually found in great abundance in the sugar centrals in the Philippines as in other sugar producing countries. Although bagasse is used as fuel in sugar centrals, usually a quantity is left unused when the milling season is over. The questions arise, what should be done with left-over sugar cane bagasse? Should it be applied to the cane fields as such? Should it first be reduced to ashes and this be applied to the fields as fertilizer? If applied as bagasse what would be its effects upon the growth and development of the cane plant?

These are pertinent questions. But the literature on studies in the Philippines on the nutritive value of the cane bagasse is wanting or at least limited. Studies made in other countries have shown that materials, such as straw and the like, rich in carbohydrate but poor in nitrogen are harmful to plants when added to soil. From this observation it might be surmised that the bagasse, being rich in carbohydrate and poor in nitrogen, might be harmful to the sugar cane plant. To secure specific information on the subject, it was deemed advisable to undertake the present experimental study.

Pot cultures were tried. Sugar cane plants were planted in pots containing ordinary garden clay loam soil and sugar cane bagasse, the latter added in different amounts. To save time and because it was suspected that the cane bagasse would prove harmful to the plant, other sets of cultures were started at the same time, primarily to discover ways and means of counteracting the harmful effects of the bagasse on the young sugar cane plants when it was added to the soil.

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[1] Thesis presented for graduation, 1932, with the degree of Bachelor of Agriculture, from the College of Agriculture, No. 379; Experiment Station contribution No. 947. Prepared in the Department of Plant Physiology under the direction of Dr. Rafael B. Espino.

Review of literature

According to Collison and Conn (1924) addition of straw or similar plant residues of highly carbonaceous nature to clay soil was detrimental to plant growth. They ascribe the detrimental effects to the stimulation of micro-organisms which compete with plants for nitrogen, and found that the harmful effects of straw was almost inversely proportional to the amount of available nitrogen present in the soil. They also found that the harmful effects could be overcome by addition of nitrate to the soil.

Doryland (1916) found that certain ammonifying organisms successfully compete with plants for plant nutrients when present in the same medium along with a good supply of energy producing, or carbonaceous materials. He reports that the activity of the organisms is determined by the ratio of the amount of energy producing materials to the amount of nitrogen present. With excess of nitrogen, he reports, these organisms promote ammonification. But with excess of the carbohydrate materials the organisms utilize ammonium or nitrate from the soil; thus decreasing nitrate accumulation and the organisms competing with the plants for this nutrient.

Viljeon and Fred (1924) report that wood and wood pulp cellulose when added to soil were harmful to oats and clover. They ascribe the harmful effects to the utilization of nitrates in the soil by the wood-decomposing organisms.

Chirikov and Shmuk (1903) experimented on the influence of moisture and straw upon denitrification in sandy-loam soil. The work was carried out in pots. They found that at a constant moisture, the yield of oats decreased as the straw in the soil was increased. Likewise, these authors reported that as the amount of moisture in the soil was increased the yield of the crop decreased. However, addition of carbonate of lime to the soil decreased the injurious effects of straw but did not overcome it. From these observations, these authors concluded that the diminished yield of crop was not due to denitrification but that the nitrates were converted into albuminoid compounds which are less assimilable by green plants than the nitrates.

Bischoff (1901) conducted pot experiments at Göttingen, in which he turned under straw, 10 weeks, 4 weeks, and immediately before planting. He grew mustard and buckwheat in a sandy and in a clayey soil. He found that in the sandy soil the use of straw was usually followed by a smaller yield of dry matter and of nitrogen. The injurious effect, however, was less in the presence of sodium nitrate. In clayey soils the straw did not uniformly de-

crease the yield. With sodium nitrate, the early application of straw produced the greatest depression in yield. In the absence of sodium nitrate the late application of straw caused the greatest loss.

Murray (1921) reported that the addition of straw to the soil stimulated the reproduction of bacteria. He contends that the bacteria use the straw as a source of carbon and use the nitrates (or in some cases ammonium sulfate) as a source of nitrogen. He also states that the nitrates are transformed to organic nitrogenous materials and for the time being are lost as available plant food.

Objects of this study

The objects of this study were, (*a*) to determine the effects of sugar cane bagasse when added to soil upon the growth and development of the young sugar cane plants; and (*b*) to determine whether or not the harmful effects of sugar cane bagasse in the soil, as indicated by the poor growth and development of the young sugar cane plants, could be neutralized or counteracted by the addition of lime, ash, horse manure, superphosphate and ammonium sulfate, separately or in certain combination and amounts.

Time and place of the study

This study was conducted in the experimental garden of the Department of Plant Physiology of the College of Agriculture from March 15, 1931 to February 18, 1932. The plants, however, in each set of cultures remained in the pots for only five months. Soon after harvesting the first sets of cultures, the pots were replanted. Unfortunately, the cane plants in the second set of cultures were severely attacked by stem borers, so it was deemed best to discard these cultures.

MATERIALS, METHODS AND RESULTS

The plant

Young sugar cane plants, variety Luzon White, were used in this study. Ordinary "seed", or cuttings of sugar cane were gathered from a field in Los Baños. The cuttings were cut into smaller pieces, each containing one bud. The smaller cuttings were first soaked in water for forty-eight hours and then planted in germinating boxes filled with sand. To hasten the sprouting of the buds, the boxes were watered from time to time. About fifteen days later when buds had sufficiently sprouted, young shoots of apparently similar vigor or state of development were selected. The selected young plants were planted in earthen pots containing equal amounts of ordinary garden clay loam soil.

Soil used

One hundred thirty-five large earthen pots (*pilones*) were filled with clay loam soil. The soil was first pulverized and afterwards thoroughly mixed. Roots of weeds and other solid bodies usually found mixed with it were removed. Each pot had a surface area of 1,256 square centimeters and contained 37,000 cubic centimeters of the soil.

Cultures tried

Eight sets of cultures were run in this study. Except the last experiment, which owing to lack of time lasted for only 75 days, each set of cultures lasted for five months before the cane plants

Fig. 1.—Showing the relative growth and development of the sugar cane plants at the age of five months grown in clay loam soil in pots containing sugar cane bagasse to which ash, lime and horse manure were added in varying amounts. From left to right: culture I, control (without treatment) culture II, sugar cane bagasse alone; culture III, sugar cane bagasse plus ash; culture IV, sugar cane bagasse plus horse manure; culture V, sugar cane bagasse plus lime; culture VI, sugar cane bagasse plus horse manure, plus ash; culture VII, ash alone.

were harvested. Representative cultures were photographed before the plants were harvested (see fig. 1-4). For convenience of study, the sets of cultures tried may be described as follows:

Experiment 1. To determine the effects upon young sugar cane plants of sugar cane bagasse when added to clay loam soil in different amounts, a set of six pot cultures were started on April 4, 1931. The cultures received bagasse at the rates of 100, 200, 300, 400 and 500 grams to a pot, or at the rates of 0, 8, 1.6, 2.4, 3.2, and 4.0 metric tons, respectively to the hectare. Three pots did not receive any bagasse and were used as control. Each culture was run in triplicate. On September 9, 1931, the plants were harvested. Data under the criteria (*a*) height of the tallest stalk, (*b*) length

of visible stalks, (*c*) diameter of visible stalks and (*d*) fresh weights of top, root, and of tops and roots were gathered. These data are recorded in table 1.

Experiment 2. In the previous experiment, the bagasse had some harmful effects on the young sugar cane plants; it was suspected that the formation of acid in the soil may have been the cause. To neutralize this acid, lime was added to the pots. Three test cultures, one control culture (no treatment) and one culture with bagasse alone were started simultaneously on April 4, 1931. Each culture was run in triplicate. The test cultures received, in addition to 400 grams of bagasse per pot, lime in different amounts (see table 2). When the cultures were five months old (on September 9, 1931), they were harvested and the experimental data shown in table 2 were recorded.

Experiment 3. To determine the nutritive value of bagasse ash when added in varying amounts to soil alone or in combination with other materials, such as sugar cane bagasse, horse manure, sulfate of ammonia, a set of sixteen cultures, each in triplicate, was started on April 4, 1931. On September 9, 1931, that is, about five months later, the cultures were harvested and experimental data recorded. The data obtained are recorded in table 3.

Experiment 4. To determine whether or not the harmful effects of the bagasse could be neutralized by addition of double superphosphate alone, or the addition of this fertilizer and of sulfate of ammonia, another set of cultures was started also on April 4, 1931. The amounts of the bagasse and of the fertilizer ingredients that were used in this set of cultures are recorded in table 4. In this table are also shown the experimental data that were gathered from the cultures at the time when they were harvested, on September 9, 1931.

Experiment 5. To determine whether or not the harmful effects of sugar cane bagasse could be neutralized by the addition of horse manure alone or in combination with other fertilizer materials, a set of fourteen cultures (see table 5), each in triplicate, was conducted for five months, also from April 4, 1931 to September 9, 1931. At the end of this period the plants were harvested and experimental data recorded (see table 5).

Experiment 6. To determine whether or not the harmful effects of sugar cane bagasse upon sugar cane plants could be neutralized by the addition to the soil of sulfate of ammonia alone or in combination with other fertilizer materials, a set of sixteen different cultures, each in triplicate, was conducted from April 4, 1931 to Sep-

tember 9, 1931. At the end of the experimental period, the cultures were harvested and experimental data recorded. The data thus obtained under different criteria of results are given in table 6.

Experiment 7. It was thought best to compare the fertilizer value of sulfate of ammonia when used alone with the fertilizer value of the same fertilizer when added to soil previously supplied with sugar cane bagasse. In this set, other culture types were included (see table 7). The culture period lasted for five months, from May 24, 1931 to October 24, 1931. The cultures were then harvested and experimental data recorded (see table 7).

Experiment 8. To determine the effects upon the sugar cane plants of sugar cane bagasse in different stages of decomposition, a set of cultures was run. This set consisted of seven cultures, each in duplicate. The young sugar cane plants were planted in pots on November 2, 1931, but the samples of bagasse in the pots were in different degrees of decomposition, ranging from fresh condition to seventy-five days in the soil in pots. Two cultures received no bagasse at all and served as control. On February 18, 1932, the cultures were photographed (see fig. 4), and subsequently harvested. The experimental data under different criteria of results are recorded in table 8.

Care of cultures

Soon after planting, the cultures were watered and the plants sheltered from the direct sunlight and heat with short pieces of fresh leaf sheaths of banana. Thereafter, the pots were watered whenever necessary. Care was taken to keep the cultures free from weeds and the soil rather loose by occasional cultivation. When the plants had begun to grow, care was taken to expose them equally to sunshine and air.

Criteria of results

External appearance of plants. From time to time the plants in the different cultures were observed and any unusual change in the appearance was recorded. The color of the leaves and any injury to any part of the plant was noted. However, most of the notes under this criterion were obtained at the time of harvest. The results of the observations on the external appearance of the plants are concisely recorded in tables 1 to 8. At the end of each experimental period, representative cultures of the different culture types or treatment were selected and photographed (see fig. 1, 2, 3 and 4).

Height of tallest stalk. At the end of each experimental period, the height of the tallest stalk in each pot was found. The tallest stalk was measured from the base mark to the node to which the oldest visible leaf sheath was still attached. The data thus obtained, as averages, are given in tables 1 to 8.

Length and diameter of visible stalk. After taking the measurement of the height of the tallest stalk in each pot, the plants were harvested. The stalks were cut at about the level of the soil in pots. Then the trash or dried leaves still clinging to the stalks were removed. To facilitate measuring the lengths and the diameters of the visible stalks, the plants from each culture were placed side by

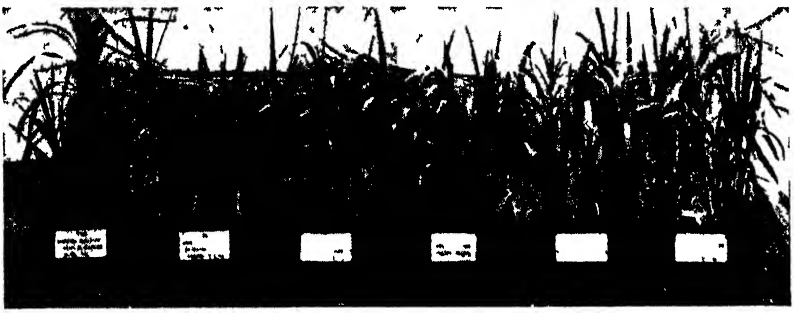

Fig 2—Showing the relative growth and development of the sugar cane plants at the age of five months, grown in clay loam soil in pots containing sugar cane bagasse to which ammonium sulfate and double superphosphate were added in varying amounts From left to right Culture VIII received 400 grams bagasse plus 81 2 grams horse manure plus 5 2 grams ammonium sulfate, culture IX, 400 grams bagasse, 14 2 grams ash plus 5 2 grams ammonium sulfate, culture X, 400 grams bagasse plus 4 0 grams double superphosphate and 2 6 grams ammonium sulfate, culture XI, 400 grams bagasse plus 10 8 grams ammonium sulfate; culture XII, 400 grams bagasse plus 8 0 grams double superphosphate; culture XIII, 81.2 grams horse manure plus 5.2 grams ammonium sulfate plus 14 grams ash.

side on a table. The lengths of the visible stalks from each culture were added together and the data obtained from the three similar cultures were averaged. Being placed side by side, the diameter of all the visible stalks, at a point about five centimeters from the base, was measured and the data obtained from each of the triplicate cultures were averaged. The data as averages are reported in tables 1 to 8.

Fresh weights of tops. The data on the fresh weights of the tops were obtained as follows: Immediately after the stalks from each culture had been cut and the lengths and diameters of the stalks de-

termined, the fresh leaves and stems gathered from each culture were weighed on a "solution balance". The data under this criterion, as averages, are given in tables 1 to 8.

Fresh weight of root. Soon after having gathered the experimental data from the tops (stems and leaves) the roots in each pot were removed from the soil. The roots were washed thoroughly with tap water and spread on a table in a room. Two hours later when the water had evaporated, the roots from each culture were weighed on a "solution balance". The data on the fresh weight of roots from the triplicate cultures were averaged. The data thus obtained are given in tables 1 to 8. The data on the *fresh weight of tops and roots* shown in tables 1 to 8 were obtained by adding the weight of fresh top and the weight of fresh roots from the same culture.

Weather observation

Fortunately, during this study covering a period from April 4, 1931 to February 18, 1932, there was only one typhoon, and that a moderate one. It occurred on August 16, 1931. Parts of many days were cloudy during the growing period of the sugar cane plants, from April to September, 1931. Clear days were more frequent during the latter part of this study—from September, 1931 to February, 1932. The monthly rainfall varied from 23.4 to 1,310.6 millimeters; the lowest occurred in January and the highest in August. The maximum temperature was 35.9°C. in April, then it gradually went down to 28.8°C. in January. The minimum temperature was 24.9°C. in April; increased to 26.2°C. in June, but went down to 24.3°C. in November. In January the average minimum temperature was 23.2°C. The mean temperature ranged from 27.5°C. to 30.5°C. The humidity of the atmosphere varied from 84.4 to 91.1 per cent during the first four months (from April to August), and 89.1 to 87.1 per cent during the last six months (from September to February).

DISCUSSION OF RESULTS

Sugar cane bagasse harmful to sugar cane plants

As shown in table 1, under the criteria of (*a*) height of tallest stalk and (*b*) fresh weight of the plant, in no instance was the application of sugar cane bagasse to the soil in pots beneficial to sugar cane plants. The control culture which did not receive any bagasse at all gave the highest yield. It appears also under the same criteria that the harmful effects upon the plant were almost proportional to the rate of application of the bagasse. As the amount of bagasse

was increased the stuntedness and the chlorotic appearance of the plants increased also. But, under the criteria of length of visible stalks and diameter of visible stalk, cultures I and II, which received the least amounts of bagasse, were better than the control culture (see also fig. 1). However, the differences were only slight and the figures for the control culture under these criteria are also relatively high. For these reasons, in spite of the slight discrepancy, it may be concluded that the addition of bagasse to clay loam soil in pots was harmful to the sugar cane plants, and that the detrimental effects were proportional to the rate of application of bagasse to the soil, corroborating Chirikov and Shmuk (1903), who found that the yield of oats decreased as the straw in the soil was increased.

Fig. 3.—Showing the relative growth and development of the sugar cane plants at the age of five months, grown in clay loam soil in pots containing sugar cane bagasse, ash, and ammonium sulfate. From left to right: culture I, control (no treatment); culture II, sugar cane bagasse alone, culture III, ash alone; culture IV, sugar cane bagasse plus ammonium sulfate; culture V, ash plus ammonium sulfate; culture VI, ammonium sulfate alone.

Effects of addition of lime

As may be seen in table 2, lime was added to culture pots in only three different amounts. More trials or cultures should have been tried, as the highest amount added to the soil in culture III gave the best yield of the plant. This yield was even slightly higher than the yield of fresh tops obtained from the control culture. It appears, therefore, that lime when added to the soil in pot at the rate used in culture III, could counteract somewhat the harmful effects of the sugar cane bagasse in the pot or at best increase the yield of tops and roots. Similar results were obtained by Chirikov and Shmuk (1903) when they applied carbonate of lime to the soil. The question now arises as to whether or not the detrimental effects of the bagasse

were due to acidity in the soil. To answer this question would require pH value determinations of the soil before and after the addition of the bagasse. In this study, these tests were not made. However, in a similar study conducted in the Department of Plant Physiology, the pH value of similar soil was determined. The results show that the soil was only slightly acid in its reactions, and that the degree of acidity was hardly increased by the addition of bagasse. In view of these findings and based on the rather limited data shown in table 2, it could not be ascertained in what way or ways the application of lime, at the rate used in culture III, proved beneficial to the plant. This result confirms Chirikov and Shmuk's (1903) findings. These authors found that the addition of carbonate of lime to the soil decreased the injurious effects of the straw but did not completely overcome it.

Bagasse ash added to soil with and without sugar cane bagasse

From table 3, it is evident that the addition of bagasse ash to sugar cane bagasse in a soil medium did not counteract the harmful effects of the bagasse. This was shown by the fact that the plants grown in cultures I, II and III were more poorly developed and had more chlorotic leaves than the plants obtained from the control culture, which did not receive any treatment at all. However, the cultures that had only bagasse ash (cultures X and XI) were better than the control culture, which finding seems to indicate that bagasse ash was more beneficial to the sugar cane plants than the bagasse.

Table 3 shows also that addition of horse manure to the bagasse ash failed to fully counteract the harmful effect of the bagasse in the soil. This is apparent by comparing the data in cultures IV, V and VI with those in the control culture. But, as shown in culture VIII or IX, in which a relatively large amount of sulfate of ammonia was added to the bagasse ash, the detrimental effect of the bagasse was fully counteracted. The latter finding seems to corroborate those of Collison and Conn (1924) showing that the harmful effects on plants of straw or any carbonaceous materials can be neutralized with the addition of nitrogen to the soil.

Table 3 further shows that any combination of horse manure, bagasse and sulfate of ammonia tried, (cultures XII, XIII and XIV) produced good yields of sugar cane plants under the criteria here employed. But the culture in this set which produced the highest yield of top or the yield of top and root (about twice as much as that obtained from the next best culture and several times the yield ob-

tained from most of the other cultures in the set) had 14.3 grams of bagasse ash, 81.2 grams of horse manure, and 5.2 grams of sulfate of ammonia. This is culture XIV in table 3.

Harmful effects of bagasse counteracted by double superphosphate

Examination of table 4 reveals that when sugar cane bagasse was used alone (culture VI), the yield of sugar cane plants, under any of the criteria or results employed, was lower than the corresponding yields obtained either from the control culture, which received no treatment at all, or lower than any of the cultures that were supplied with double superphosphate or sulfate of ammonia or both fertilizers. These results seem to indicate that the harmful effects of the bagasse could be neutralized by any of the treatments given. Cultures I and II which received only double superphosphate in addition to the 400 grams of sugar cane bagasse were better than cultures V and VI. This finding seems to show that the harmful effects to the plant by the bagasse in clay loam soil could be amply neutralized not only by the addition of nitrogen to the culture media (cultures III and IV) but even by addition of double superphosphate at the rates of 4 to 8 grams per culture.

Horse manure alone cannot counteract harmful effects of bagasse

Examination of the data in table 5 shows that cultures I to VII, under any of the criteria of results employed, were inferior to the control culture, which did not receive any treatment at all. All the cultures from I to VII received sugar cane bagasse at the rate of 400 grams per pot and likewise received, in addition, a certain amount of horse manure, or horse manure and bagasse ash, or as in culture VII, horse manure and only 1.3 grams of sulfate of ammonia. These results seem to show, therefore, that the depressing effects of the 400 grams of sugar cane bagasse could not be counteracted by low application of a non-nitrogen carrier, such as the bagasse ash or manure with low nitrogen content, as horse manure. Even the addition of 1.3 grams of sulfate of ammonia together with a little horse manure proved futile in neutralizing the bad effects of the bagasse. As the amounts, however, of horse manure and of sulfate of ammonia were increased, the harmful effects of the bagasse seem to have been correspondingly diminished. The data in cultures VIII and IX when compared with those in culture XIII, the control, bear out this conclusion. This result confirms findings by Doryland (1916). This

author found that certain ammonifying organisms will successfully compete with plants for plant nutrient present in the same medium along with a good supply of energy producing carbonaceous materials. Doryland reports that with excess of nitrogen these organisms promote ammonification, but with excess of carbohydrate materials, they utilize ammonia or nitrate from the soil; thus lessening nitrate accumulation and competing with the plants for food. This same author also reports that straw applied at the rate of 20 tons per acre will greatly decrease the ammonifying power of soil and increase the consumption of ammonia and nitrogen.

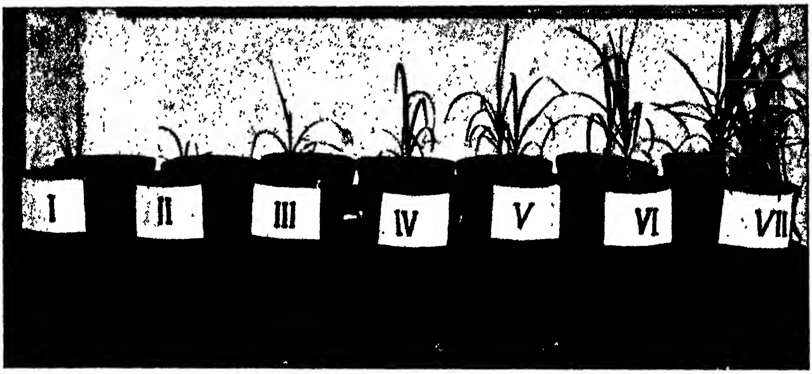

Fig. 4.—Showing the relative growth and development of sugar cane plants at the age of three months, grown in clay loam soil in pots and treated with sugar cane bagasse at intervals of 15 days. From left to right: I, sugar cane bagasse recently added in soil; II, sugar cane bagasse 15 days in soil; III, sugar cane bagasse 30 days in soil; IV, sugar cane bagasse 45 days in soil; V, sugar cane bagasse 60 days in soil; VI, sugar cane bagasse 75 days in soil; VII, control (no treatment).

Cultures X, XI and XII, which did not have any bagasse at all, were better than any of the cultures that received the 400 grams bagasse and better still than the control culture. These three cultures together with the culture IX, as indicated by Hs (for high yield signs) are arbitrarily the first four best cultures in this set. The treatments received by these cultures and the good results derived thereof suggest the advisability of using no bagasse in cultures of sugar cane plants. They likewise suggest that sugar cane bagasse may be added even at the rate of 400 grams to the pot (see culture IX) provided, that at least 81.2 grams horse manure and 5.2 grams sulfate of ammonia were also to be added to the culture media.

Harmful effects of bagasse counteracted by sulfate of ammonia

The data in table 6 show that in term of the green weights of the plants, cultures I, II, IV and IX were less nourishing than the control culture, which did not receive any treatment at all. These cultures received relatively low amounts of ammonium sulfate, but when this fertilizer was used at much higher rates, it proved effective in counteracting the harmful effects of the 400 grams of sugar cane bagasse in the pots. Cultures III, VI, VIII, and X bear out this generalization. In these cultures the sulfate of ammonia was used at the rate of 5.2 grams per culture. Even with a little smaller amount, however, the detrimental effects of the bagasse were somewhat neutralized when the bagasse was supplemented with any of the fertilizer material or materials employed. As shown in table 6, of the cultures that received the 400 grams of bagasse, five; namely, cultures III, VI, VIII, X and XI, each produced green weights of top and root exceeding 1,200 grams. Cultures X and XI, each of which received only ammonium sulfate, were better than the others of these selected cultures. It would seem that the sulfate of ammonia was more effective in counteracting the harmful effects of the bagasse when used alone than when something else was combined with it. As shown by the data in cultures III, VI, and VIII in table 6, the addition of double superphosphate to the sulfate of ammonia at the rate 400 grams per pot proved less beneficial to the sugar cane plant and therefore less efficient in destroying the depressing effects of the bagasse, than the addition either of 81.2 grams of horse manure or of 14.3 grams bagasse ash.

All the cultures (table 6, cultures XII, XIII, and XIV) that received sulfate of ammonia, horse manure, and bagasse ash combined, but without sugar cane bagasse, were far better than either the control culture or any of the cultures that had the 400 grams of bagasse. In fact, of all the cultures reported in table 6, the best results were obtained from this group—from culture XIV, which received 14.3 grams of bagasse ash, 81.2 grams horse manure, and 5.2 grams sulfate of ammonia.

In a later experiment (table 7), the high nutritive value of sulfate of ammonia to sugar cane plant and the harmful effects of sugar cane bagasse upon this plant was once more revealed. The data for cultures I, III, IV, and V in table 7, bear out these claims. But, although once more the bagasse ash proved to be a better fertilizer material for sugar cane plant than the bagasse (comparing cultures I and II in table 7) yet this time, under the criteria of green weights of the plants, the bagasse ash was inferior to the control culture, which did

not receive any treatment at all (see fig. 3). The difference, however, was only slight and may even be considered as insignificant (see cultures II and VI in table 7). Moreover, it should be noted that culture II received only 14.2 grams of bagasse ash, an amount not as beneficial to the plant as the 28.6 grams of the same material reported in table 3.

Comparing now cultures III, IV and V in table 7, cultures which received sulfate of ammonia, alone or in combination with another fertilizer material, it will be seen that they all proved to be quite equally nutritive to the plant. Of the three cultures, however, and under the criterion of green weights of the plants, culture III was the best. This result seems to indicate again that the harmful effects of bagasse (especially in this case when only 100 grams were used instead of 400) were not only fully neutralized but that the combination was more than twice as good as the control culture and more than three times as good as the culture that received only the bagasse. This culture was even better than culture IV, which contained 14.2 grams bagasse ash and 10.4 grams sulfate of ammonia, and also better than culture V, which was supplied only with 10.4 grams of sulfate of ammonia.

Harmful effects of bagasse diminished with degree of decomposition in soil

Other conditions being equal, the longer the bagasse stays in the soil, the greater is its chance to decompose. In this experiment, care was taken to use the same kind and the same amounts of soil, to use samples of sugar cane bagasse of the same amounts and from the same stock or source, to water the pots at the same time and with the same amounts, and to equally expose the pots to the sun and the air. For these reasons, it is probably safe to conclude that the degree of decomposition of the bagasse was proportional to the length of time that the samples of bagasse had been in the soil. No actual physical or chemical analysis of the culture media was made. Casual observation, however, revealed that the samples of bagasse that were applied earlier appeared to be more thoroughly rooted than the samples of later application.

Now, turning attention to the data in table 8, and recalling that all the cultures were planted at the same time, it is seen that the plants in the different cultures were of the same age. But the degree of development seems to be proportional to the length of time that the bagasse had been in the soil. In other words, the harmful effects of the bagasse diminished with the degree of its decomposition. The

data in table 8 bear out this contention, as culture I, which received the sample of bagasse at the time of planting gave the lowest or poorest yield. The yields under the criteria employed seem to be progressively on the increase from culture I to culture VI; the last culture had the bagasse in the soil for 75 days.

Culture VII, which did not receive any treatment at all, was better than any of the cultures recorded in table 8 that received samples of sugar cane bagasse. This culture produced plants even better developed than those obtained from culture VI, which had the bagasse most thoroughly decomposed (see fig. 4). Whether or not further decomposition of the bagasse would fully eliminate the harmful effects when added to soil remains unknown. Owing to lack of time, this was not tested in this study.

SUMMARY AND CONCLUSIONS

1. Sugar cane bagasse added to clay loam soil in pots was harmful to the young sugar cane plants; the detrimental effects being almost proportional to the amounts used.

2. Lime when added to soil in pots at the rate of 22 grams per culture (or 4 metric tons to the hectare) neutralized a little the harmful effects of the bagasse. At smaller amounts, the addition of lime to the cultures produced no neutralizing effects.

3. Bagasse ash added to pots failed to counteract the detrimental effects of the bagasse. But when only bagasse ash was added to the soil the growth of the young sugar cane plants was improved.

4. The best development of the young plant was obtained when 14.3 grams of bagasse ash, 21.2 grams horse manure and 5.2 grams sulfate of ammonia were added to the soil in pot without bagasse.

5. The harmful effects to the plant by the bagasse were amply neutralized by the addition of superphosphates to the culture.

6. The depressing effects upon the plant of sugar cane bagasse in the pot were not counteracted by the horse manure.

7. The harmful effects of the bagasse was fully neutralized by the addition to the culture of 81.2 grams horse manure and 5.2 grams sulfate of ammonia.

8. Liberal use of ammonium sulfate fully destroyed the harmful effects of the bagasse; limited application of this fertilizer gave no apparent beneficial effects in counteracting the bad effects of the bagasse.

9. All the cultures to which sulfate of ammonia, horse manure, and bagasse ash (combined) were added to the soil with bagasse

were better than the control culture (only soil) or any of the cultures containing 400 grams of bagasse.

10. The harmful effects of the bagasse diminished with the degree of its decomposition; but the control plant (no bagasse) was still better developed than the plants supplied with the most thoroughly decomposed bagasse tested that is, 75 days in the soil in pots.

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TABLE 1

Showing the relative effects upon the growth and development of young sugar cane plants of sugar cane bagasse when added to clay-loam soil in pots in varying amounts

CULTURE NO.	AMOUNT OF BAGASSE USED	HEIGHT OF TALLEST STALK	LENGTH OF VISIBLE STALK	DIAMETER OF VISIBLE STALK	FRESH WEIGHT			EXTERNAL APPEARANCE OF PLANTS
					Tops	Roots	Tops and roots	
	grams	*cm.*	*cm.*	*cm.*	*grams*	*grams*	*grams*	
I	100	63.9	39.3	2.2	425.0	38.0	463.0	Plants poorly developed; leaves slightly chlorotic, few roots.
II	200	59.8	37.0	2.4	396.3	48.3	444.6	Plants stunted, leaves slightly chlorotic, few roots.
III	300	28.7	6.3	1.5	136.3	21.0	157.3	Plants extremely stunted, with narrow and short chlorotic leaves, few roots.
IV	400	39.1	16.9	1.8	266.6	26.3	292.9	Plants stunted with chlorotic leaves and undeveloped root systems.
V	500	29.1	8.8	1.6	160.3	20.6	180.6	Plants extremely stunted with chlorotic leaves, few roots.
VI	None (control)	74.6	29.5	2.1	531.0	62.0	593.0	Plants normally developed, with normal green leaves.

TABLE 2

Showing the relative effects on the growth and development of young sugar cane plants when lime in varying amounts was added to clay-loam soil containing sugar cane bagasse [a]

CULTURE NO.	TREATMENT GIVEN	HEIGHT OF TALLEST STALK	LENGTH OF VISIBLE STALK	DIAMETER OF VISIBLE STALK	FRESH WEIGHT			EXTERNAL APPEARANCE OF PLANTS
					Tops	Roots	Tops and roots	
		cm.	*cm.*	*cm.*	*grams*	*grams*	*grams*	
I	400 grams sugar cane bagasse and 5.5 grams lime	34 9	3.4	1 66	210.0	33.0	243.0	Plants stunted, leaves chlorotic, few roots.
II	400 grams sugar cane bagasse and 11.0 grams lime	48.9	5 5	1.84	180.0	31.0	211.0	Plants stunted in growth with chlorotic leaves, few roots.
III	400 grams sugar cane bagasse and 22 grams lime	67 4	18.9	1 97	593.3	71 7	665.0	Plants normally developed; leaves slightly chlorotic. Fairly developed root system.
IV	400 grams sugar cane bagasse	39.1	16.1	1.8	266 6	26.3	292.9	Plants stunted with chlorotic leaves and poorly developed root system.
V	None (control)	74.6	29.5	2.14	531.0	62.0	593.0	Plants normally developed.

[a] Volume of soil in pot, 37,000 cubic centimeters, and the surface area of pot, 1,256 square centimeters.

TABLE 3

Showing the relative effects on the growth and development of young sugar cane plants when ash in varying amounts was added alone or in combination with other material or materials to clay loam soil containing sugar cane bagasse [a]

CULTURE NO.	TREATMENT GIVEN	HEIGHT OF TALLEST STALK	LENGTH OF VISIBLE STALK	DIAMETER OF VISIBLE STALK	FRESH WEIGHT			EXTERNAL APPEARANCE OF PLANTS
					Tops	Roots	Tops and roots	
		cm.	*cm.*	*cm.*	*grams*	*grams*	*grams*	
I	400 grams sugar cane bagasse and 7.15 grams bagasse ash	55.0	19.1	1.81	384.6	51.6	436.2	Plants poorly developed with pale green leaves; few roots.
II	400 grams sugar cane bagasse and 14.3 grams bagasse ash	41.6	13.9	1.77	174.0	24.3	198.3	Plants poorly developed with slightly chlorotic leaves; few roots.
III	400 grams sugar cane bagasse and 28.6 grams bagasse ash	42.2	16.5	1.99	186.6	21.0	207.6	Plants stunted, leaves narrow and chlorotic; roots poorly developed.
IV	400 grams sugar cane bagasse, 7.15 grams bagasse ash and 20.3 grams horse manure	40.7	3.5	1.86	160.3	23.3	183.6	Plants poorly developed with chlorotic leaves and undeveloped root system.
V	400 grams sugar cane bagasse, 14.3 grams bagasse ash and 40.6 grams horse manure	39.5	3.5	1.90	181.0	20.6	201.6	Plants stunted, leaves slightly chlorotic; undeveloped root system.
VI	400 grams sugar cane bagasse, 28.6 grams bagasse ash and 81.2 grams horse manure	61.4	16.7	1.94	337.6	36.6	374.2	Plants poorly developed, with pale green leaves; few roots.
VII	400 grams sugar cane bagasse, 3.58 grams bagasse ash and 1 3 grams ammonium sulfate [b]	47 6	10.6	1 86	198.3	55.0	253.3	Plants poorly developed; leaves chlorotic; few roots.

[a] Volume of soil in a pot, 37,000 cubic centimeters, and the surface area of a pot, 1,256 square centimeters.
[b] Sulfate of ammonia was applied at rate of from one-fourth to one-half ton per hectare.

TABLE 3 (Continued)

CULTURE NO.	TREATMENT GIVEN	HEIGHT OF TALLEST STALK	LENGTH OF VISIBLE STALK	DIAMETER OF VISIBLE STALK	FRESH WEIGHT			EXTERNAL APPEARANCE OF PLANTS
					Tops	Roots	Tops and roots	
		cm.	*cm.*	*cm.*	*grams*	*grams*	*grams*	
VIII	400 grams sugar cane bagasse, 7.16 grams bagasse ash and 2.6 grams ammonium sulfate	62.4	21.3	2.06	545.0	79.6	624.6	Plants well developed with broad green leaves; abundance of roots.
IX	400 grams sugar cane bagasse, 14.3 grams bagasse ash and 5.2 grams ammonium sulfate	88.2	24.9	2.23H	1294.0H	123.0H	1417.0H	Plants dark green; vigorous; abundance of roots.
X	14.3 grams bagasse ash	92.9H	37.4H	2.37H	786.0	100.5	886.5	Plants well developed; with broad green leaves; abundance of roots.
XI	28.6 grams bagasse ash	113.0H	52.5H	2.60H	1236.5H	118.0H	1354.5H	Plants well developed with green broad leaves.
XII	20.3 grams horse manure, 3.58 grams bagasse ash and 1.3 grams ammonium sulfate	95.2H	31.3H	2.22H	979.3H	116.0H	1095.3H	Plants well developed; vigorous; abundance of roots.
XIII	7.16 grams bagasse ash, 40.6 grams horse manure and 2.6 grams ammonium sulfate	112.1H	38.8H	2.28H	1275.3H	143.0H	1418.3H	Plants well developed; vigorous; abundance of roots.
XIV	14.3 grams bagasse ash, 81.2 grams horse manure and 5.2 grams ammonium sulfate	128.3H	44.8H	2.56H	2327.3H	196.3H	2523.6H	Plants rather well developed; abundance of roots. Best looking plants.
XV	400 grams sugar cane bagasse	39.1	16.9	1.8	266.6	26.3	292.9	Plants stunted with chlorotic leaves and poorly developed roots.
XVI	None (control)	74.6	29.5	2.14	531.0	62.0	593.0	Plants normally developed.

TABLE 4

Showing the relative effects on the growth and development of young sugar cane plants when double superphosphate and ammonium sulfate or combination of the two were added in different amounts to soil containing sugar cane bagasse[a]

CULTURE NO.	TREATMENT GIVEN	HEIGHT OF TALLEST STALK	LENGTH OF VISIBLE STALK	DIAMETER OF VISIBLE STALK	FRESH WEIGHT			EXTERNAL APPEARANCE OF PLANTS
					Tops	Roots	Tops and roots	
		cm.	*cm.*	*cm.*	*grams*	*grams*	*grams*	
I	400 grams sugar cane bagasse and 4.0 grams double superphosphate	103.1	51.6	2.74	567.0	57.5	624.0	Plants well developed with pale green leaves.
II	400 grams sugar cane bagasse and 8.0 grams double superphosphate	119.1	26.1	2.35	1328.0	111.5	1439.5	Plants dark green, vigorous; well developed root systems.
III	400 grams sugar cane bagasse, 2.0 grams double superphosphate and 2.6 grams ammonium sulfate	116.4	48.1	2.46	605.0	71.5	676.5	Plants well developed.
IV	400 grams sugar cane bagasse, 4.0 grams double superphosphate and 5.2 grams ammonium sulfate	98.4	35.6	2.36	1147.5	110.0	1257.5	Plants well developed, vigorous; abundance of roots.
V	400 grams sugar cane bagasse	39.1	16.9	1.8	266.6	26.3	292.9	Plants stunted with chlorotic leaves and poorly developed root systems.
VI	None (control)	74.6	29.5	2.14	531.0	62.0	593.0	Plants normally developed.

[a] Volume of soil in pot, 37,000 cubic centimeters, and the surface area of pot, 1,256 square centimeters.

TABLE 5

Showing the relative effects on the growth and development of the young sugar cane plants when horse manure in varying amounts was added alone or in combination with other material or materials to clay loam soil containing sugar cane bagasse [a]

CULTURE NO.	TREATMENT GIVEN	HEIGHT OF TALLEST STALK	LENGTH OF VISIBLE STALK	DIAMETER OF VISIBLE STALK	FRESH WEIGHT			EXTERNAL APPEARANCE OF PLANTS
					Tops	Roots	Tops and roots	
		cm.	*cm.*	*cm.*	*grams*	*grams*	*grams*	
I	400 grams sugar cane bagasse and 40 6 grams horse manure	38 8	11.2	1.32	255.0	49.0	304.0	Plants stunted, leaves slightly chlorotic; few roots.
II	400 grams sugar cane bagasse and 81.2 grams horse manure	41.6	10.9	1 64	197.0	34.0	231.0	Plants stunted, leaves slightly chlorotic; few roots.
III	400 grams sugar cane bagasse and 162.4 grams horse manure	59.9	13.9	1.86	341 3	46.3	487.6	Plants poorly developed, with narrow and chlorotic leaves; few roots.
IV	400 grams sugar cane bagasse, 20.3 grams horse manure and 7.15 grams bagasse ash	40 7	3 5	1.86	160 3	23.3	183 6	Plants stunted, leaves slightly chlorotic; few roots.
V	400 grams sugar cane bagasse, 40 6 grams horse manure and 14.3 grams bagasse ash	39.5	3.45	1.90	181.0	20.6	20.6	Plants stunted, leaves slightly chlorotic; few roots.
VI	400 grams sugar cane bagasse, 81.2 grams horse manure and 28.6 grams bagasse ash	61.4	16.7	1 94	337.6	36.6	374.2	Plants poorly developed with narrow and chlorotic leaves; few roots.
VII	400 grams sugar cane bagasse, 20.3 grams horse manure and 1 3 grams ammonium sulfate	56 8	13.3	2 02	357.3	50.6	407.9	Plants fairly developed with leaves, narrow and short.

[a] Volume of soil in pot 37,000 cubic centimeters, and the surface area of pot 1,256 square centimeters.

TABLE 5 (Continued)

CULTURE NO.	TREATMENT GIVEN	HEIGHT OF TALLEST STALK	LENGTH OF VISIBLE STALK	DIAMETER OF VISIBLE STALK	FRESH WEIGHT			EXTERNAL APPEARANCE OF PLANTS
					Tops	Roots	Tops and roots	
		cm.	*cm.*	*cm.*	*grams*	*grams*	*grams*	
VIII	400 grams sugar cane bagasse, 40.6 grams horse manure and 2.6 grams ammonium sulfate	80.0	32.3H	2.25	507.3	52.6	559.9	Plants fairly well developed.
IX	400 grams sugar cane bagasse, 81.2 grams horse manure and 5.2 grams ammonium sulfate	106.1H	35.5H	2.31H	1315.3H	140.0H	1455.3H	Plants well developed, vigorous, abundance of roots.
X	20.3 grams horse manure, 3.58 grams bagasse ash and 1.3 grams ammonium sulfate	95.2H	31.3	2.22H	979.3H	116.0H	1095.3H	Plants well developed, vigorous, abundance of roots.
XI	40.6 grams horse manure, 7.16 grams bagasse ash and 2.6 grams ammonium sulfate	112.1H	38.8H	2.28H	1275.3H	143.3H	1418.6H	Plants dark green; vigorous, abundance of roots.
XII	81.2 grams horse manure, 14.3 grams bagasse ash and 5.2 grams ammonium sulfate	128.3H	44.8H	2.56H	2327.3H	196.3H	2523.6H	Plants well developed, vigorous, abundance of roots.
XIII	400 grams sugar cane bagasse	39.1	16.9	1.8	266.6	26.3	292.9	Plants stunted with chlorotic leaves and poorly developed root systems.
XIV	None (control)	74.6	29.5	2.14	531.0	62.0	593.0	Plants normally developed.

TABLE 6

Showing the relative effects on the growth and development of the young sugar cane plants when ammonium sulfate in varying amounts was added alone or in combination with other materials to clay loam soil containing sugar cane bagasse

CULTURE NO.	TREATMENT GIVEN	HEIGHT OF TALLEST STALK	LENGTH OF VISIBLE STALK	DIAMETER OF VISIBLE STALK	FRESH WEIGHT: Tops	FRESH WEIGHT: Roots	FRESH WEIGHT: Tops and roots	EXTERNAL APPEARANCE OF PLANTS
		cm.	*cm.*	*cm.*	*grams*	*grams*	*grams*	
I	400 grams sugar cane bagasse, 20.3 grams horse manure and 1.3 grams ammonium sulfate	56.8	13.3	2.02	357.4	50.6	408.0	Plants fairly good looking but leaves narrow and slightly chlorotic.
II	400 grams sugar cane bagasse, 40.6 grams horse manure and 2.6 grams ammonium sulfate	80.0	32.3	2.25	507.4	52.6	560.0	Plants slightly better looking than those in culture I.
III	400 grams sugar cane bagasse, 81.2 grams horse manure and 5.2 grams ammonium sulfate	106.1H	35.5H	2.31H	1315.3H	140.0H	1455.3H	Plants well developed; vigorous; abundance of roots.
IV	400 grams sugar cane bagasse, 3.58 grams bagasse ash and 1.3 grams ammonium sulfate	47.6	10.6	1.86	198.3	55.0	253.3	Plants poorly developed leaves rather narrow and short; few roots.
V	400 grams sugar cane bagasse, 7.16 grams bagasse ash and 2.6 grams ammonium sulfate	62.4	21.3	2.06	545.0	79.6	624.6	Plants fairly good looking leaves pale green fairly developed root system.
VI	400 grams sugar cane bagasse, 14.3 grams bagasse ash and 5.2 grams ammonium sulfate	88.2	24.9	2.23	1294.0H	123.0	1417.0	Plants dark green; vigorous; abundance of roots.
VII	400 grams sugar cane bagasse, 2.0 grams double superphosphate and 2.6 grams ammonium sulfate	116.4H	48.1H	2.46H	605.0	71.5	676.5	Plants dark green; vigorous; abundance of roots.
VIII	400 grams sugar cane bagasse, 4.0 grams double superphosphate and 5 2 grams ammonium sulfate	98.4	35.6	2.36H	1147.5	110.0	1257.5	Plants dark green; vigorous; abundance of roots.

TABLE 6 (Continued)

CULTURE NO.	TREATMENT GIVEN	HEIGHT OF TALLEST STALK	LENGTH OF VISIBLE STALK	DIAMETER OF VISIBLE STALK	FRESH WEIGHT Tops	FRESH WEIGHT roots	FRESH WEIGHT Tops and roots	EXTERNAL APPEARANCE OF PLANTS
		cm.	*cm.*	*cm.*	*grams*	*grams*	*grams*	
IX	400 grams sugar cane bagasse and 2.6 grams ammonium sulfate	65.8	19.9	1.90	436.0	89.6	525.6	Plants fairly well developed; leaves pale green.
X	400 grams sugar cane bagasse and 5.2 grams ammonium sulfate	99.9H	35.5	2.25	1830.0H	182.3H	2012.3H	Plants dark green; healthy; abundance of roots.
XI	400 grams sugar cane bagasse and 10.4 grams ammonium sulfate	87.8	32.8	2.37H	1590.0H	205.6H	1795.6H	Plants well developed; vigorous; abundance of roots.
XII	3.58 grams bagasse ash, 20.3 grams horse manure 1.3 grams ammonium sulfate	95.2	31.3	2.22	979.3	116.0	1095.3	Plants well developed, with broad green leaves.
XIII	7.16 grams bagasse ash, 40.6 grams horse manure and 2.6 grams ammonium sulfate	112.1H	38.8H	2.28	1275.3	143.0H	1418.3	Plants well developed, with broad green leaves.
XIV	14.3 grams bagasse ash, 81.2 grams horse manure and 5.2 grams ammonium sulfate	128.3H	44.8H	2.56H	2327.3H	196.3H	2523.6H	Plants rather well developed; vigorous; abundance of roots.
XV	400 grams sugar cane bagasse	39.1	16.9	1.8	266.6	26.3	292.9	Plants stunted with chlorotic leaves and poorly developed root systems.
XVI	None (control)	74.6	29.5	2.14	531.0	62.0	593.0	Plants normally developed.

TABLE 7

Data obtained from additional cultures that received various fertilizer treatments as shown below[a]

CULTURE NO.	TREATMENT GIVEN	HEIGHT OF TALLEST STALK	LENGTH OF VISIBLE STALK	DIAMETER OF VISIBLE STALK	FRESH WEIGHT			EXTERNAL APPEARANCE OF PLANTS
					Tops	Roots	Tops and roots	
I	100[b] grams sugar cane bagasse	86	104	78	65	62	65	Plants poorly developed; leaves chlorotic.
II	14.2 grams bagasse ash	122	115	95	97	91	96	Plants normally developed with normal green leaves.
III	100 grams bagasse 10.4 grams sulfate of ammonia	156	171	121	260	198	254	Plants had dark green leaves, vigorous; abundance of roots.
IV	14.2 grams bagasse ash 10.4 grams sulfate of ammonia	156	180	126	208	179	204	Plants dark green; vigorous; abundance of roots.
V	10.4 grams sulfate of ammonia	166	198	123	241	180	235	Plants dark green; vigorous; abundance of roots.
VI	None (control)	100 (72.7 cm.)	100 (16.9 cm.)	100 (1.84 cm.)	100 (597.3 grams)	100 (49.0 grams)	100 (645.3 grams)	Plants normally developed

[a] The data under each criterion are in relative values. The actual value for the control was arbitrarily taken as 100; the others were reduced relatively.

[b] Sulfate of ammonia was applied, at rate of from one-fourth to one-half ton per hectare.

TABLE 8

Showing the comparative effects on the growth and development of young sugar cane plants of sugar cane bagasse at different stages of decomposition[a]

CULTURE NO.	TREATMENT GIVEN	HEIGHT OF PLANT			FRESH WEIGHT OF TOP			FRESH WEIGHT OF ROOT			FRESH WEIGHT OF TOP AND ROOT			EXTERNAL APPEARANCE OF PLANTS
		a	b	Av.	a	b	Av.	a	b	Av.	a	b	Av.	
		cm.	*cm.*	*cm.*	*grams*	*grams*	*grams*	*grams*	*grams*	*grams*	*grams*	*grams*	*grams*	
I	Bagasse recently added in soil	7.6	6.0	6.8	4.2	3.2	3.7	1.2	0.9	1.05	5.4	4.1	4.75	Plants extremely stunted.
II	Bagasse 15 days in soil	11.4	Dead	11.4	5.8	Dead	5.8	2.1	Dead	2.1	7.9	Dead	7.9	Plants extremely stunted.
III	Bagasse 30 days in soil	13.2	7.4	10.2	9.6	2.5	6.1	2.9	0.9	1.9	12.5	3.4	7.95	Plants extremely stunted.
IV	Bagasse 45 days in soil	17.5	12.1	14.8	14.0	6.0	10.0	4.0	3.3	3.65	14.4	9.3	11.25	Plants extremely stunted.
V	Bagasse 60 days in soil	18.0	19.0	18.5	20.0	21.0	20.5	7.5	5.9	6.8	27.5	26.9	27.2	Plants extremely stunted.
VI	Bagasse 75 days in soil	22.2	20.1	21.2	65.0	45.0	55.00	15.5	10.4	12.95	80.5	55.4	67.95	Plants poorly developed.
VII	None (control)	22.7	33.4	28.1	99.0	149.0	124.0	25.1	47.0	34.03	124.1	196.0	160.5	Plants normally developed.

[a] Cultures started August 19, 1931, harvested February 18, 1932.

PUBLISHED CONTRIBUTIONS OF THE COLLEGE OF AGRICULTURE: XI[1]

B. M. GONZALEZ
Dean, College of Agriculture

We present herewith a list of the published contributions of the College of Agriculture for the academic year 1933-34.

The year has been almost a normal one in research productivity, largely resulting from the momentum of previous years. A slackening in the former pace is beginning to be noticeable, however; the faculty of the College is less by about twenty per cent of what it was two or three years ago, and the support of the institution has suffered a similar reduction, and the end is not yet in sight. Commercial and governmental institutions have also been pressing forward with alluring offers to secure the services of valuable faculty members, thus depleting further the man power necessary for the carrying on of an active research program.

The greatest menace, however, comes from well-meaning administrators who view the functioning of the institution in terms purely instructional and financial. In their effort to balance the University budget they seek to assess the activities of the College staff largely or solely on the basis of classroom teaching, as if it were possible to base the teaching of Philippine agriculture, or the agriculture of any country for that matter, on anything but local facts and experiences which must painstakingly be sought from nature before they can be presented before the students and the public.

Considering that this College is the only agricultural institution of University grade in the Philippines, and the pioneer in the tropical field, wherein similar institutions are still few, far between, and inadequate, the outlook should evoke profound concern in all farseeing statesmen.

It is most fortunate, however, that the spirit of high emprise in the line of extending the bounds of human knowledge has gripped the personnel of this institution, so that in spite of difficulties besetting the progress of work, a certain measure of intellectual productivity may normally be expected from these quarters.

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[1] General contribution from the College of Agriculture No. 397.

II. EXPERIMENT STATION CONTRIBUTIONS

The contributions are numbered serially as reported. For Nos. 1-199, *see* THE PHILIPPINE AGRICULTURIST XII, No. 7, 1923. For Nos. 200-287, *see* THE PHILIPPINE AGRICULTURIST XIII, No. 10, March, 1925. For Nos. 288-354, *see* THE PHILIPPINE AGRICULTURIST XIV, No. 10, March, 1926. For Nos. 355-440, *see* THE PHILIPPINE AGRICULTURIST XV, No. 10, March, 1927. For Nos. 441-517, *see* THE PHILIPPINE AGRICULTURIST XVI, No. 10, March, 1928. For Nos. 518-595, *see* THE PHILIPPINE AGRICULTURIST XVII, No. 10, March, 1929. For Nos. 596-643, *see* THE PHILIPPINE AGRICULTURIST XIX, No. 2, July, 1930. For Nos. 644-710, *see* THE PHILIPPINE AGRICULTURIST XIX, No. 10, March, 1931. For Nos. 711-799, *see* THE PHILIPPINE AGRICULTURIST XX, No. 10, March, 1932. For Nos. 800-880 *see* THE PHILIPPINE AGRICULTURIST XXI, No. 10, March, 1933.

(881) SANTOS, F. O., AND NAZARIO A. PIDLAOAN. 1933. The food of the male inmates of Bilibid prisons. The Journal of the Philippine Islands Medical Association 13, No. 11: p. 493–501.

(882) TEODORO, A. L. 1933. Alcohol as a possible source of motor fuel. Sugar News 14: 81–83.

(883) KING, R. H. 1933. Notes on the Olivarius process; use and possible adaptation to Philippine molasses. Sugar News 14: 231–234. *Fig. 1–2.*

(884) TALEON, A. T., VALENTE VILLEGAS, AND MAMERTA MANAHAN-YLAGAN. 1933. The digestibility by the carabao of flint corn silage. The Philippine Agriculturist 22: 13–22.

(885) CAGUICLA, PURIFICACION M. 1933. Selection of varieties and strains of mungo (*Phaseolus aureus* Roxb.). The Philippine Agriculturist 22: 23–42. *Fig. 1–2.*

(886) BASIO, ENGRACIO. 1933. A comparative study of the emasculator and the emasculatome methods of castration. The Philippine Agriculturist 22: 43–65. *Pl. 1.*

(887) KING, R. H. 1933. Technical and economic aspects of cane purchase and sugar distribution. Sugar News 14: 123–130; 181–184; 237–241; 281–285.

(888) KING, R. H., AND SALVADOR B. OLIVEROS. 1933. On the partial removal of certain alkalies by zeolite from, and the effect upon the crystallization of sucrose and the viscosity of final molasses. Sugar News 14: 436–441.

(889) STEVENS, F. L., AND MATHILDA SCHNEIDER. 1933. Philippine Hemisphaeriaceae. University of the Philippines Natural and Applied Science Bulletin 3: 21-26. *Fig. 1–4.*

(890) JULIANO, JOSÉ B., AND PROCESO E. ALCALA. 1933. Floral morphology of *Musa errans* (Blanco) Teodoro var. Botoan Teodoro. The Philippine Agriculturist 22: 91–125. *Pl. 1–5; Fig. 1.*

(891) CATAMBAY, ALEJANDRO B., AND JULIAN C. JUGO. 1933. Cost of production of lowland rice in the College of Agriculture. The Philippine Agriculturist 22: 127–147.

(892) FRONDA, F. M. 1933. A study of the results of the Second Philippine Egg Laying Contest. The Philippine Agriculturist 22: 148–156.

(893) SORIANO, ALEJANDRO V. 1933. Sweet potato, *Ipomoea batatas* Linn. vs. *Calopogonium muconoides* Desv., a legume, as pasture crops for growing pigs. *Abstract in* The Philippine Agriculturist 22: 157–158.

(894) MADRID, PEDRO Z. 1933. The effect of different soil media on the rate of growth of cacao (*Theobroma cacao* L.) seedlings. The Philippine Agriculturist 22: 172–188. *Fig. 1–7; charts 1–2.*

(895) TANTOCO, CESAR B. 1933. Studies on the use of a Pateros hatcher in incubating chicken eggs. The Philippine Agriculturist 22: 189–201.

(896) SURATOS, FELICISIMO D. 1933. A study of the palatability and feeding value of some Philippine plants for goats. The Philippine Agriculturist 22: 202–218.

(897) TIONGSON, WENCESLAO N. 1933. Some clarification characteristics of cane juice. *Abstract in* The Philippine Agriculturist 22: 220–221.

(898) MERCADO, TORIBIO, AND PEDRO JUACHON. 1933. A report on a rice inbreeding experiment in the College of Agriculture. The Philippine Agriculturist 22: 234–253. *Fig. 1–3.*

(899) JULIANO, JOSÉ B. 1923. Additional Cyanophoric plants of the Maquiling Region: IV. The Philippine Agriculturist 22: 254–257.

(900) CATAMBAY, ALEJANDRO B., AND JESUS E. SEGOVIA. 1933. Cost of producing sugar cane in the College of Agriculture. The Philippine Agriculturist 22: 258–273.

(901) ATIENZA, JOSÉ C. 1933. Studies on the consumption of sugar for one year by fifty Filipino families in Calauan, Laguna. The Philippine Agriculturist 22: 274–284.

(902) UICHANCO, CONRADO B. 1933. Hens and pullets as sources of eggs for foundation stocks. The Philippine Agriculturist 22: 285–297.

(903) KING, R. H., AND N. L. JISON. 1933. On the destruction of sucrose in "A" molasses by heat. Sugar News 14: 24–27.

(904) AQUINO, D. I., AND D. P. TABIJE. 1933. Observations on the decomposition of cellulose in certain Philippine forest soils. The Philippine Agriculturist 22: 311–321. *Fig. 1.*

(905) RAMOS, MARIANO M. 1933. Mechanical injuries to roots and corms of abaca in relation to heart-rot disease. The Philippine Agriculturist 22: 322–337.

(906) TIOAQUEN, TELESFORO. 1933. Comparative studies on the growth and maturity of Los Baños Cantonese and Nagoya chickens. The Philippine Agriculturist 22: 338–355. *Chart 1.*

(907) SAMSON, JUAN N. 1933. The amount of residual arsenic on leafy vegetable crops sprayed and dusted with arsenical insecticides. The Philippine Agriculturist 22: 356–371.

(908) TEODORO, A. L. 1933. Notes on some tillage implements in Cuba. Philippine Machinery Journal 4, No. 5: 29–35.

(909) TEODORO, A. L., SANTIAGO R. CRUZ, AND ENRIQUE M. BAUTISTA. 1933. Characters of power-consumption curves of some tractor-engine fuels. Philippine Machinery Journal 4, No. 5: 19–26.

(910) OCFEMIA, G. O. EVARISTO A. HURTADO, AND CRISPINIANO C. HERNANDEZ. 1933. Distribution of mosaic and Fiji diseases in sugar cane stalks; effects of these maladies on the germination of the eyes and transmission of the viruses by pin pricks. The Philippine Agriculturist 22: 383–407. *Fig. 1–6.*

(911) PADILLA, SALVADOR P., AND FLORENCIO A. SOLIVEN. 1933. Chemical analysis for possible sources of oils of forty-five species of oil bearing seeds. The Philippine Agriculturist 22: 408–415.

(912) MARTIR, LADISLAO. 1933. A study on the comparative economy of egg production of the Nagoya and of the Los Baños Cantonese breeds of fowls. The Philippine Agriculturist 22: 416–429.

(913) MACEDA, FELICISIMO. 1933. A study of coconut seedlings in relation to shape of the nuts. The Philippine Agriculturist 22: 430–441. *Fig. 1–2.*

(914) ARAGON, VICENTE. 1933. A further study of nitrification in Philippine soils. *Abstract in* The Philippine Agriculturist 22: 442–443.

(915) PENDLETON, ROBERT L. 1933. A reconnaissance soil survey of a portion of Kwantung Province. The Geological Survey of China Soil Bulletin 6: 1–224. 52 pl.; 1 map (colored). (Including translation in Chinese, 50 p.)

(916) PENDLETON, ROBERT L. 1933. Cogonals and reforestation with *Leucaena glauca.* Lingnan Science Journal 12: 555–568. *Pl. 1–8.*

(917) MENDIOLA, NEMESIO, B. 1933. A method of plant improvement based on the use of hidden heritable bud variations and those produced through injury. The Philippine Agriculturist 22: 465–508. *Fig. 1–8.*

(918) LEGASPI, MELECIO T. 1933. Changes in chemical composition of Cantonese eggs in holding. The Philippine Agriculturist 22: 509–520.

(919) ENRIQUEZ, ELEUTERIO P. 1933. Preliminary studies on the influence of the presence of males upon the growth and maturity of pullets. *Abstract in* The Philippine Agriculturist 22: 521–522.

(920) ESPINO, R. B., AND F. T. PANTALEON. 1934. Harmful effects upon rice and maize plants of rice straw when added to clay soil in pots. The Philippine Agriculturist 22: 534–556. *Fig. 1–9.*

(921) DAVID, PEDRO A. 1934. Soap making on the farm. The Philippine Agriculturist 22: 557–566. *Fig. 1–3.* (*See Circular No. 25.*)

(922) OCFEMIA, G. O., AND GABINO G. BUHAY. 1934. Bunchy-top of abaca, or Manila hemp: II. Further studies on the transmission of the disease and a trial planting of abaca seedlings in a bunchy-top devastated field. The Philippine Agriculturist 22: 567–581. *Fig. 1–2.*

(923) FRONDA, F. M., ACELO C. BADELLES, AND JUAN S. PADILLA. 1934. Protein supplements in poultry rations: I. Comparative studies of the

effects of shrimp meal, meat scraps, tankage and fish meal as supplements in rations for growing chickens. The Philippine Agriculturist 22: 582–598. *Charts 1–2.*

(924) RELOVA, FELIXBERTO. 1934. The coconut industry in Pila, Laguna. *Abstract in* The Philippine Agriculturist 22: 599–600.

(925) KING, R. H. 1933. A simple, inexpensive sample saver. Sugar News 14: p. 322.

(926) KING, R. H., AND ERNESTO VILLAREAL. 1933. On the separate clarification and characteristics of the last mill juice. Sugar News 14: 533–545.

(927) KING, R. H. 1933. The inclined, trough, gravity, continuous subsider. Sugar News 14: 275–276.

(928) ARAGON, VICENTE B. 1933. How to grow peanuts. The Stockman and Farmer 1: 3–5.

(929) ARAGON, VICENTE B. 1933. The cost of producing lowland rice in the Philippines. University of the Philippines Natural and Applied Science Bulletin 2: 417–439.

(930) CALMA, VALERIANO C., AND L. W. OWEN. 1929. The effect of organic carbon on the toxic effects of metallic copper on the fermentation of molasses for the production of industrial alcohol. Centralblatt für Bacteriologie, Parasitenkunde and Infektionskranheiten.——

(931) CALMA, V. C., AND H. W. RICHEY. 1930. Influence of the amount of foliage on rooting of Coleus cuttings. Proceedings of the American Society for Horticultural Science 27: 457–482.

(932) CALMA, V. C., AND H. W. RICHEY. 1931. Growth of Concord Grape cuttings in relation to vigor, chemical composition and relative position on the cane. Proceedings of the American Society for Horticultural Science 28: 131–136.

(933) CALMA, V. C. 1933. The comparative merits of top and cut-back seedpieces of sugar cane (*Saccharum officinarum*). Sugar News 14: 131–137.

(934) CALMA, V. C. 1933. The relation of carbohydrate-nitrogen ratio to root formation in Coleus cuttings. Iowa State Journal of Science. ——

(935) GONZALEZ, B. M. 1933. Hog raising for beginners. The Stockman and Farmer 1, No. 1: p. 8, 9, 28, 32.

(936) VILLEGAS, VALENTE. 1933. The Hereford: a factor in breed improvement. The Stockman and Farmer 1, No. 1: p. 3, 22, 27.

(937) MANRESA, MIGUEL. 1933. Physiology of reproduction in the rabbit. Age of sexual maturity, breeding season, duration of normal pregnancy, and ovulation. The Philippine Journal of Science 51: 323–330.

(938) MANRESA, MIGUEL, D. CLEMENTE, AND S. R. CRUZ. 1933. The rate of improvement in the breeding of farm animals by the method of mass selection as affected by varying number of factors. *Abstract in* The Gazette 3: p. 88. (Philippine Bureau of Animal Industry.)

(939) TEODORO, A. L. 1934. Effects of pre-heating on the operation of a high compression tractor engine using alcohol and alcohol-gasoline blends as fuels. The Philippine Agriculturist 22: 625–652. *Fig. 1–2; Charts 1–6.*

(940) UICHANCO, LEOPOLDO B., AND SANTIAGO R. CAPCO. 1934. Effect of various methods of storing corn on the degree of damage due to weevils. The Philippine Agriculturist 22: 653–672. *Fig. 1–3.*

(941) CRUZ, RAMON, AND RICARDO T. MARFORI. 1934. Chemical analysis of the water supply of the College of Agriculture for the year 1931–1932. The Philippine Agriculturist 22: 673–684.

(942) FRANCISCO, ALFREDO A., GREGORIO S. CHAN, AND F. M. FRONDA. 1934. Protein supplements in poultry rations: II. Comparative effects of shrimp meal, meat scraps, tankage and fish meal as supplements in rations for laying hens. The Philippine Agriculturist 22: 685–697. *Charts 1–2.*

(943) ARCEDO, PERICO Y. 1934. A comparative study of manimanihan, *Alysicarpus nummularifolius* (Linn.) D. C. and *Desmodium capitatum* (Burm. f.) as forage crops. *Abstract in* The Philippine Agriculturist 22: 698–699.

(944) SOLIVEN, FLORENCIO A. 1934. A preliminary study on the elimination of the acid error by the use of phosphoric acid for the direct and invert readings. The Philippine Agriculturist 22: 708–719.

(945) TEODORO, A. L., AND J. P. MAMISAO. 1934. Report on truck field tests in Canlubang, Laguna, using A-alkohl motor fuel No. 1, B-dehydrated alcohol and gasoline as fuels. The Philippine Agriculturist 22: 720–744. *Charts 1–2.*

(946) VELMONTE, JOSÉ E., JUAN O. SUMAGUI, AND PEDRO H. VIRAY. 1934. Living conditions in farm homes in Mendez Nuñez and Amadeo, Cavite; Mangatarem, Pangasinan; and Camiling, Tarlac. The Philippine Agriculturist 22: 745–776.

(947) MALABAYABAS, ARTEMIO P. 1934. Effects on the growth and development of sugar cane plant of bagasse when added to soil in pots. The Philippine Agriculturist 22: 778–803. *Fig. 1–4.*

(948) ANIOAY, DOMINGO. 1934. Some preliminary studies on the propagation of cacao (*Theobroma cacao* L.) by stem cuttings and by graftage. *Abstract in* The Philippine Agriculturist 22: 813.

III. GENERAL CONTRIBUTIONS

The contributions are numbered serially as reported. For Nos. 1-104, *see* THE PHILIPPINE AGRICULTURIST XII, No. 7, December, 1923. For Nos. 105-141, *see* THE PHILIPPINE AGRICULTURIST XIII, No. 10, March, 1925. For Nos. 142-164, *see* THE PHILIPPINE AGRICULTURIST XIV, No. 10, March, 1926. For Nos. 165-184, *see* THE PHILIPPINE AGRICULTURIST XV, No. 10, March, 1927. For Nos. 185-203, *see* THE PHILIPPINE AGRICULTURIST XVI, No. 10, March, 1928. For Nos. 204-216, *see* THE PHILIPPINE AGRICULTURIST XVII, No. 10, March, 1929. For Nos. 217-266, *see* THE PHILIPPINE AGRICULTURIST XIX, No. 2, July, 1930. For Nos. 267-288, *see* THE PHILIPPINE AGRICULTURIST XIX, No. 10, March, 1931. For Nos. 289-308, *see* THE PHIL-

IPPINE AGRICULTURIST XX, No. 10, March, 1932. For Nos. 308-348[1] *see* THE PHILIPPINE AGRICULTURIST XXI, No. 10, March, 1933.

(349) GONZALEZ, B. M. 1933. On Research. The Philippine Agriculturist 22: 1–12.

(350) SACAY, FRANCISCO M. 1933. A preliminary study of pupils in vocational agriculture. The Philippine Agriculturist 22: 165–171.

(351) FRONDA, F. M. 1933. Editorials. Philippine Poultry Journal 2, No. 5: p. 2; No. 6: p. 3; No. 7 p. 3.

(352) BASIO, ENGRACIO. 1933. In the poultry yards. Philippine Poultry Journal 2, No. 5: p. 10–11; No. 6: p. 10–11; No. 7: p. 10–11; No. 8: p. 10; No. 9: p. 12; No. 10: p. 13; No. 11: p. 15; No. 12: p. 10.

(353) BASIO, ENGRACIO. 1933. There are jobs with chickens. Philippine Poultry Journal 2, No. 9: p. 4, 15.

(354) PENDLETON, ROBERT L. 1932. The soil survey of China. Report of the Twelfth Annual Meeting of the American Soil Survey Association, Houma, Louisiana. Bull. 13: 89–93.

(355) MANRESA, MIGUEL. 1933. A review: "Poultry breeding." The Philippine Agriculturist 22: 298–299.

(356) PENDLETON, ROBERT L. 1933. Notes on Kwantung fibers. Lingnan Science Journal 12: 409–413. *Pl. 1–5.*

(357) MONSALUD, M. R. 1933. Note: Banana. The Philippine Agriculturist 22: 372–373.

(358) PENDLETON, ROBERT L. 1933. China's relation to commercial fertilizers. The Industrial Center (Nanking, China) 2: 149–151; 203–208.

(359) PENDLETON, ROBERT L. 1933. Fashions in soil survey. Sugar News 14: 488–493.

(360) FRONDA, F. M. 1933. Go over your flocks again. Philippine Poultry Journal 3, No. 1: p. 6, 7, 21.

(361) BASIO ENGRACIO. 1933. Raise chickens in the back yard. Philippine Poultry Journal 3, No. 1: p. 8, 21.

(362) PENDLETON, ROBERT L. 1933. International coöperation in agriculture. The Philippine Agriculturist 22: 381–384.

(363) PENDLETON, ROBERT L. 1933. Potato gluten. Lingnan Science Journal 12: 603–604. *Pl. 1.*

(364) FRONDA, F. M. 1933. The Society for the Advancement of Research. The Philippine Agriculturist 22: 451–454.

(365) UICHANCO, LEOPOLDO B. 1933. Science and the scientist. The Philippine Agriculturist 22: 455–458.

(366) OCFEMIA, G. O. 1933. Disease resistance in plants. (Summary of address by Prof. L. R. Jones) The Philippine Agriculturist 22: 459–464.

(367) DE LEON, ANTONIO I. 1933. War chemicals in time of peace. The Pharos 3, No. 5: 1, 16.

[1] Through an error, No. 308 was repeated as first number of 1933 list. Hence, No. 348 in this list should be No. 349. To make totals correct No. 399 instead of 398 will be first number in 1934 list.

(368) PENDLETON, ROBERT L. 1933. Making muscovado sugar in Jolo. Sugar News 14: 599–601. *Fig. 1–4.*

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(370) PENDLETON, ROBERT L., L. C. CHANG, W. CHEN, AND K. C. HOU. 1932. Soil survey of the Salachi area Suiyuan Province, China. National Geological Survey of China Bulletin 4: 1–26. *Pl. 1–8; colored map.*

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IV. CIRCULARS

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No. 25.—DAVID, PEDRO A. 1934. Soap making on the farm. (*See* Experiment Station contribution No. 921.)

V. MISCELLANEOUS CONTRIBUTIONS

(From outside the College and translations)

The contributions are numbered serially as reported. For Nos. 1-6, *see* THE PHILIPPINE AGRICULTURIST XX, No. 10, March, 1932. For Nos. 7-10, *see* THE PHILIPPINE AGRICULTURIST XXI, No. 10, March, 1933.

(11) PENDLETON, ROBERT L. 1933. Tropical soil-forming processes and the development of tropical soils. VII + p. 200. Peiping: National Geographical Survey of China. Translation of "De Grond van Java en Sumatra" by E. C. Jul. Mohr. (This publication is listed in mimeograph form as No. 655, Experiment Station contribution.)

ABSTRACT [1]

Some preliminary studies on the propagation of cacao (*Theobroma cacao* L.) by stem cuttings and by graftage. DOMINGO ANIOAY. (*Thesis presented for graduation, 1932, with the degree of Bachelor of Science in Agriculture from the College of Agriculture No. 380; Experiment Station contribution No. 948*).—The objects of this study were: (*a*) To study the possibility of growing cacao by cuttings; (*b*) to determine the effect of potassium permanganate solution of different concentrations on the rooting and growth of cacao cuttings; and (*c*) to study the adaptability of grafting as applied to cacao (*Theobroma cacao* L.).

Two thousand seven hundred cuttings of cacao of the variety Forastero, different concentrations of potassium permanganate; namely, 0.5, 1.5, 2.0, 2.5, and 3.0 per cent and fifty-four boxes of ordinary garden soil mixed in equal proportion with sifted sand were used. Fifty cuttings were planted in each box. Under each treatment, 450 cuttings were planted. Fermenting horse manure and water heated over an ordinary kerosene lamp were used as source of bottom heat. Some cuttings were planted in a box chamber closed with glass plates.

The ordinary methods of inarching, generally called grafting by approach and cleft grafting, were used.

The author obtained the following results:

The concentration of potassium permanganate solution used did not give consistent effect on the treated cuttings. Certain percentages of rooted cuttings were found in 2.0 per cent, but were lower than the control. The concentration of potassium permanganate solution used in this experiment did not show in the results any advantage over the control. A good percentage of success in rooting was obtained by reduced transpiration. Cacao cuttings responded somewhat to bottom heat. Cleft grafting does not seem to be adapted to cacao. Cacao in the seedling stage was propagated without much difficulty by inarching under nursery conditions.

Abstract by Benigno Legaspi

[1] Abstract prepared as part of the required theme work in English 3a, College of Agriculture.

CURRENT NOTES

The Government [Southern Rhodesia] has organised a campaign for the destruction of [locust] hoppers and is responsible for hoppers on crown lands and in native reserves. In settled areas the owners are responsible for the destruction of hoppers, free poison being issued, and pumps being loaned to those responsible.

International Review of Agriculture, April, 1933.

As it is not generally realized that restrictions on the import of plants by air are necessarily more rigid than those applicable to imports by sea, the relevant rule is given below for general information:

"Rule 2A—No plant shall be imported into British India by air, provided that plants which are infested with living insects and are intended for the introduction of such living insects may be so imported if they are accompanied by a special certificate from the Imperial Entomologist to the Government of India that such plants are imported for the purpose of introducing such insects.

Agriculture and Live-stock in India, September, 1933.

The circumstances in which mustard can be used in veterinary practice are essentially similar to those arising in human beings.

In the relief of local pain the mustard poultice or plaster is invaluable. The size of the poultice naturally depends on the size of the animal for which it is intended and also the area of the body affected. The poultice is prepared by making the mustard into a thin paste with lukewarm water. It is applied to the affected area and it should be left for a period of time depending on the intensity of the pain. No poultice, however, should be left on for more than twenty minutes. In addition to the pains caused by muscular stiffness, &c., such pains as flatulent colic can be relieved by the application of a mustard poultice at the site of the pain.

In preparing a mustard poultice or bath, boiling water or water above 140 deg. Fahr. should not be added directly to the mustard owing to the fact that the enzyme myrosin would be inactivated. Where a really hot poultice is required it is best to mix the mustard with a little cold or lukewarm water and allow to stand for a few minutes to enable the volatile oil to be liberated. Boiling water can then be added if desired. It is not desirable to apply a mustard

poultice to broken skin. If a poultice made from mustard alone is too strong, it can be made less potent by mixing it with lineseed meal or with flour.

Queensland Agricultural Journal, October, 1933

Bananas grown in India have recently arrived in London for the first time. They form an experimental shipment, and are of the Cavendish variety; those surviving faulty packing are of excellent appearance. Experimental packages of mangoes and mangosteens have been sent to London lately, but bananas are of much greater importance just now owing to the enormous damage to crops by hurricane in Jamaica. With improved methods of packing Indian bananas should be very welcome. In the summer of 1932, a number of experimental shipments of mangoes were made to London, and as a result the Indian Government Research Council is considering the allotment of large sums to provide refrigerated transport wagons enabling the mango crop to be picked ripe instead of green as at present, and to arrive at the ports in fine condition. A Russian expert who invented the "Z" process of quick freezing is now in India cooperating with the authorities. *Extract from Empire Production and Export,* April, 1933.

Reprinted in *The Journal of the Jamaica Agricultural Society* August, 1933.

Within the last year a disease has been observed in Cyprus citrus orchards which may well give cause for alarm. The disease, the causal organism of which is the fungus *Diplodia natalensis,* Evans, was originally described as a rot of lemon fruits in South Africa in 1910. A year later a similar rot was described in Florida, and in Porto Rico in 1913; it is now present and causes serious losses in most citrus-producing countries. It has only recently been observed in Cyprus.

The Cyprus Agricultural Journal, March, 1933

The Philippine Islands and the Dutch East Indies are the greatest coconut producing areas. Ceylon shares third place with the British South Sea Islands whose coconut products are about one-third those of the two premier producers.

The United States takes very largely of the Philippine exports which enjoy a tariff exemption imposed on coconut oil from all other sources.

It is possible that the future may see a great advance in the use of coir.

The Tropical Agriculturist (Ceylon), April, 1933.

South India enjoys an abundant supply of materials for making soap, but the utility of some of these was not generally understood until the Government Soap Institute at Calicut showed how various vegetable oils could be profitably employed. This Institute was started at Tanur, seventeen years ago by Sir Frederic Nicholson, as a branch of the Fisheries Station, and the field of research was gradually extended to include work on lubricating oils and paints as well as on the deodorization and hydrogenation of oils. India exports over a million tons of oil seeds annually, and a large part of the oil extracted returns in the form of fats or refined oils. The Soap Institute at Calicut is devising methods which may be employed by peasants and the industrialists for the extraction and utilization of these oils. (Chem. & Ind., Vol. II, 1932, p. 1038.)

Reprinted in *Tropical Agriculture*, April, 1933.

COLLEGE AND ALUMNI NOTES

On December 15, 1933 President Palma made his last visit to the Campus in the capacity of President of the University. His resignation became effective December 31. In recognition of the nature of the visit classes were suspended from 10:00 a. m. to 2:30 p. m. In the "ceremonies" of the day, the School of Forestry and the College of Agriculture acted as one body. At 10:00 a. m. President Palma with Dean Gonzalez and Dean Fischer left the Administration Building for Baker Memorial Hall escorted by the Cadet Band, officers of the Los Baños unit, U. P. Corps of Cadets with the U. P. Flag; cadets were posted on each side of the road at intervals of ten yards. At Baker Hall, President Palma was received by the Chairman of Committee on Social Affairs and the heads of departments of School of Forestry and the College who escorted him and the deans to the stage. For the first time in recent years the faculty and the student body of each institution were each seated as a unit.

The exercises were simple but impressive. The program follows:

University Song—"U. P. Band"
By College of Agriculture, School of Forestry, Rural High School and Faculties.

Forestry's Farewell
By Dean Arthur F. Fischer

School of Forestry Song—"Men of the Forest We"—Clarence Neff
By Forestry Students and Faculty.

Reve de Jeunesse .... F. Winternitz
By Dr. D. I. Aquino on the violin accompanied on the piano by Prof. Manuel A. Roa

Agriculture's Farewell
By Dean B. M. Gonzalez

College of Agriculture Song—"Hail College Dear"—Leopoldo B. Uichanco
By College of Agriculture Students and Faculty.

Solo "Nasaan ka Irog" .... N. Abelardo
By Mrs. M. Manahan-Ylagan accompanied at the piano by Prof. Manuel A. Roa

Palma Yell
By College of Agriculture, School of Forestry, Rural High and Faculties

Farewell Address .... President Rafael Palma

University Song—"U. P. Beloved"
By College of Agriculture, School of Forestry, Rural High School and Faculties.

Song Leaders: Abel Silva, Elsa Roa and Valentin Guillermo

At the close of "U. P. Beloved" the President and the two deans left the stage and followed by department heads and faculty members marched to Molawin Hall where from the porch the President reviewed the student bodies as in orderly procession headed by the Cadet Band, then the Cadet Corps they marched by. Never had the students made so fine an appearance.

A luncheon tendered by the faculties of the two Colleges followed the review. In the after dinner speaking Prof. Hugh C. Curran represented the School of Forestry faculty and Vicente Marababul the student body; Dr. F. M. Sacay the College of Agriculture faculty and Adolfo Castillo the student body. Alejandro Roces Jr. in behalf of the student body of the College presented a handsome cane to President Palma. Professor Emma S. Yule acted as toastmaster.

The Committee of Social Affairs merits high praise for the well planned program for the day and above all for the well executed plan. With a large hall on the Campus, now, our public days should be conducted with system and dignity befitting colleges. This day's program was so conducted and the effect was most satisfying and pleasing.

In the afternoon at a formal tree planting the President planted a Royal Palm on Forestry Campus. This was followed by a formal review of cadets on the Campus Parade Grounds.

In the evening, Dean and Mrs. Gonzalez entertained with a bridge-supper in honor of President Palma. The supper was enlivened by an effective student torch parade. The President at different times during the day and evening expressed himself as being deeply touched by the appreciation and respect expressed by the students and faculties.

At Center, on the evening of January 13, Dr. Harriet Bigelow, Head, Department of Astronomy, Smith College, who is visiting her sister, Mrs. J. B. Rodgers of Manila, gave a talk on "Astronomy for beginners". The talk was illustrated with diagrams and pictures projected on a screen. Later, Doctor Bigelow used the sky itself, (which unfortunately was clear only in spots) for illustrations and graciously answered questions asked.

The courtesy of this lecture is warmedly appreciated by the students and faculty.

Dr. Otto Reinking, first head of the Department of Plant Pathology, according to a letter to Professor Yule, is in Berlin working on fungi in which he is specially interested. He has been in Germany some two years. Doctor Reinking had been plant pathologist with United Fruit Company for several years spending most of his time in Central America.

Early in the morning on February 3 Dr. Valeriano Calma and Miss Isolina Palma of Concepcion, Tarlac were married in the Catholic Chapel, Father Casey officiating. Among the guests at the wedding breakfast at Molawin Hall were members of the family of the bride and groom, personal home friends and members of the faculty.

Doctor Calma is an alumnus '26 of this College and is now on the Agronomy Department staff. Doctor and Mrs. Calma will live on Faculty Hill in the residence formerly the home of Dr. and Mrs. A. K. Gomez.

Dr. F. M. Fronda recently received a long and most interesting letter from Mr. Pablo Mellisa, an "Extension graduate" 1932, now owner and manager of Andaliguid Poultry Farm near Iloilo, *telephone 494.* This project is only a little over one year old, but it boasts four

buildings, the brooder house being 24 × 56 ft., and 250 layers. Mr. Mellisa's goal for the present year is 900 layers. Quoting from his letter:

"Our excess cockerels and culls are absorbed by a restaurant. We have regular customers for our table eggs. . . . We deliver the eggs twice a week. . . . We have customers for our hatching eggs at ₱10 a hundred. . . . We feel that we have accomplished something worth while for the first year of the farm's life. Now we are on the early stretch of our second year—ever hopeful, ever enthusiastic—that something better, something bigger will be accomplished. "Poultry fever," I like to call it, like the recent gold fever that gripped Manila is at present beginning to manifest itself in this region of the Visayas. The future seems so full of promise."

A shipment of Red Scindi cattle consisting of one bull and three cows arrived on the College Campus on December 8. This is a dairy breed of Indian cattle which will be used in the Department of Animal Husbandry in connection with its animal improvement work.

It is reported in the *Wiley Bulletin* of November, 1933 that Deming's *Introductory Chemistry* has been already adopted by 30 well-known colleges and universities.

Dr. Horace A. Deming, the author was head of the Department of Chemistry of this College from 1911-1916.

His first chemistry text, *General Chemistry*, published in 1923 is a widely used and deservedly popular college text.

The eighty-ninth regular scientific meeting of the Los Baños Biological Club was held in the Lecture Hall of the Poultry Building, College of Agriculture, January 25, 1934, at 7:30 p. m.

The following papers were read and discussed:

1. "A new juice squeezer for pre-harvest analysis of sugar cane." By Mr. Toribio Mercado.
2. "Notes on medicinal plants found in the Makiling National Park and its vicinity." By Mr. Mamerto D. Sulit.

In a letter received by Dr. M. Manresa from Mr. Thuan Komkris B. S. Agr. '33 now on the staff of the Haadyai Agricultural Experiment Station, Siam is this interesting comment: "I am pleased to note in the *Philippine Magazine* that Filipino women have been granted the right of suffrage. The editor of the magazine boasts in an editorial that the Philippines is the first country in the Far East to grant her women suffrage. His false statement necessitated my writing to tell him that the Siamese women have been enjoying this right since 1932."

Mr. Ignacio R. Ang, B. Agr. '32, with the senior class of the Central Luzon Agricultural School, Muñoz, Nueva Ecija made an official visit to the College on February 9. Mr. Ang is adviser of the senior class. He reported the following alumni as fellow members of the faculty of the Central Luzon Agricultural School: Nazario Sadorra, B.S.A. '23; Jose M. San Juan, B.Agr. '23; Salvador F. Bolivar, B.S.A., '28; Dimas Maulit, B.S.A., '29; and Domingo G. Anioay, B.S.A. '32.

In the last Civil Service Examination for Junior Teacher of Agriculture Mr. Paulino E. Costa, instructor in Horticulture in the U. P. Rural High School in the Department of Agricultural Education of this College ranked first and Mr. Ignacio R. Ang, '32 B. Agr. second.

Among our graduates now located in Occidental Negros are: Catalino Buligan, '28, Epitacio Lanuza, '30, and Jesus E. Segovia, '33 all at La Granja Sugar Cane Station of Bureau of Plant Industry in La Carlota. Mr. Buligan in charge of entomology, Mr. Segovia in charge of sugar cane breeding, and Mr. Lanuza in charge of horticulture and assistant superintendent of the station.

At Bacolod at the Provincial Agricultural Demonstration Station are Ladislao Martir, '33 in charge of the animal industry project, and Olimpio Fontanilla, '33 in charge of the plant industry project.

Dominador Tan '32 is chemist in the distillery department of Central Lopez in Sagay Fabrica.

The sixth annual Los Baños Student Conference met at Center for a four day session— December 26-29, 1933. Twenty-four provinces were represented. The registration was 85. There were special delegates from Manila, Tayabas, Batangas, Laguna and Albay. Among the registrants were college students, high school students, teachers, nurses, deaconesses and one provincial employee. One of the College of Agriculture student registrants was Mr. Rasuman Macalandong, a Mohammedan. This is the fifth conference he has attended. The work of the conference consisted of discussion groups, open forums, lectures and dramas on religious and moral subjects. Among the well-known leaders were Dr. D. S. Hibbard, former President of Silliman Institute, Rev. E. M. Sobrepeña, Doctor Tabuñar, President of National University, Rev. E. K. Higdon and J. W. Mooman Y. M. C. A. Secretary. Among the special speakers was Mr. Teodoro Yangco. Not only did the concrete floor of basement

of Center, a gift from friends in the United States, add to the comfort of the delegates but also the sleeping cots made of abacá cloth. The use of this material instead of canvas for making cots originated with Rev. Hugh Bousman, Student Pastor of U. E. Church. The delegates were unanimous in praise of the comfort of these cots.

At Center on the evening of January 20 the Mimics presented the following program:

CAMPUS VARIETIES

Part I

March .... Herber Clark

Cadet Orchestra

Ambrosio Junio	Tranquilino San Pedro
Justo Reyes	Ambrosio Ramos
Benjamin Eleazar	Teotimo Sevilla
Cecilio Pangga	Vicente Madrigal
Anselmo Afalla	Leoncio Ricarte
Aquilino Platon	Mariano Perlas

Daily Doesn'ts .... A sketch

Physical Culture Authority .... Antonio Ocampo
His Wife .... Elsa Roa

Romeo and Juliet .... Song Stunt

Melanio Rana	Romolo Gines
Laureano Lucas	Venancio Duarte
Leopoldo Alicbusan	Rasuman Macalandong
Raul Arana	Constantin Valera
Jose Borromeo	Flaviano Olivares
Andres Caranto	Victoriano Antonio

Back to the Woodshed .. .. A skit

Pa	Federico Reyes
Ma	Vicente Castelo
Jimmy, their son	Romeo Espino
Jenny, his wife	Gabriel Flores

Negro Spirituals

Jose Borromeo	Melanio Rana
Victoriano Antonio	Constantin Valera

Chorus "John Peel"

Melanio Rana	Constantin Valera
Leopoldo Alicbusan	Flaviano Olivares
Jose Borromeo	Victoriano Antonio
Raul Arana	Gabriel Flores
Romolo Gines	Vicente Castelo
Venancio Duarte	Francisco Gomez
Romeo Espino	Antonio Ocampo
Andres Caranto	Primo Castro
Federico Reyes	Felix Flores
Rasuman Macalandong	Laureano Lucas

Business is Business .... A Skit

The Doctor	Flaviano Olivares
Morris Goldstein	Celestino Quilang
Alie, his son	Rasuman Macalandong
Rachel, his daughter	Felix Remigio
Sam, his son-in-law	Jose Borromeo
The Lawyer	Andres Caranto

Music .... { "A night in June" / "Palihan ng Bayan" } .... By Cadet Orchestra

Part II

It Isn't Done .... A Sketch

The Poet	Gabriel Flores
The Guard	Venancio Duarte
Raul Arana	by himself.

Duet .... "Sing me to Sleep"
Mrs. Manahan-Ylagan and Francisco Gomez

Dramatized Song—"The Old Oaken Bucket"

Felix Remigio	Felix Flores
Celistiano Quilang	Victoriano Antonio
Antonio Ocampo	Flaviano Olivares
Francisco Gomez	Constantin Valcra
Vicente Castelo	Rasuman Macalandong
Federico Reyes	Andres Caranto
Romeo Espino	Jose Borromeo
Leopoldo Alicbusan	Melanio Rana
Romolo Gines	Primo Castro
	Laureano Lucas

Etiquette .... A Sketch

She	Elsa Roa
He	Raul Arana

Director	Miss Anne F. Cole
Music Director	Mrs. Hugh Bousman
Stage Manager	Dr. Antonio I. de Leon

This type of program was selected by the Mimics director with the object of giving the members drill in presenting skits and sketches, some original, some adapted. Also in presenting songs in character.

Each number was well presented. Space does not permit the merited special mentions. The "Old Oaken Bucket" sung by a group of farmers around a most realistic old well with pulley and bucket, made this beautiful old song mean something to the students.

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